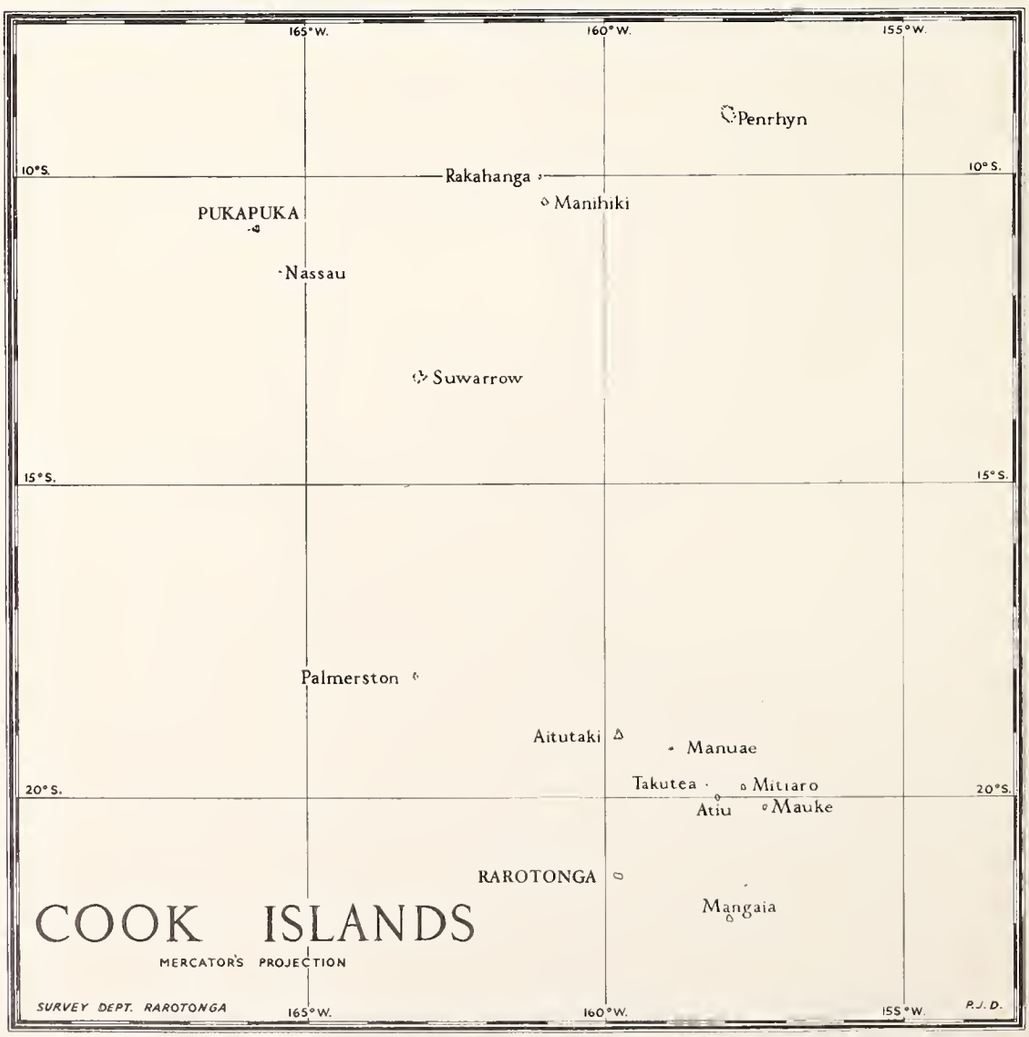
DEPARTMENT OF HEALTH
SPECIAL REPORT SERIES

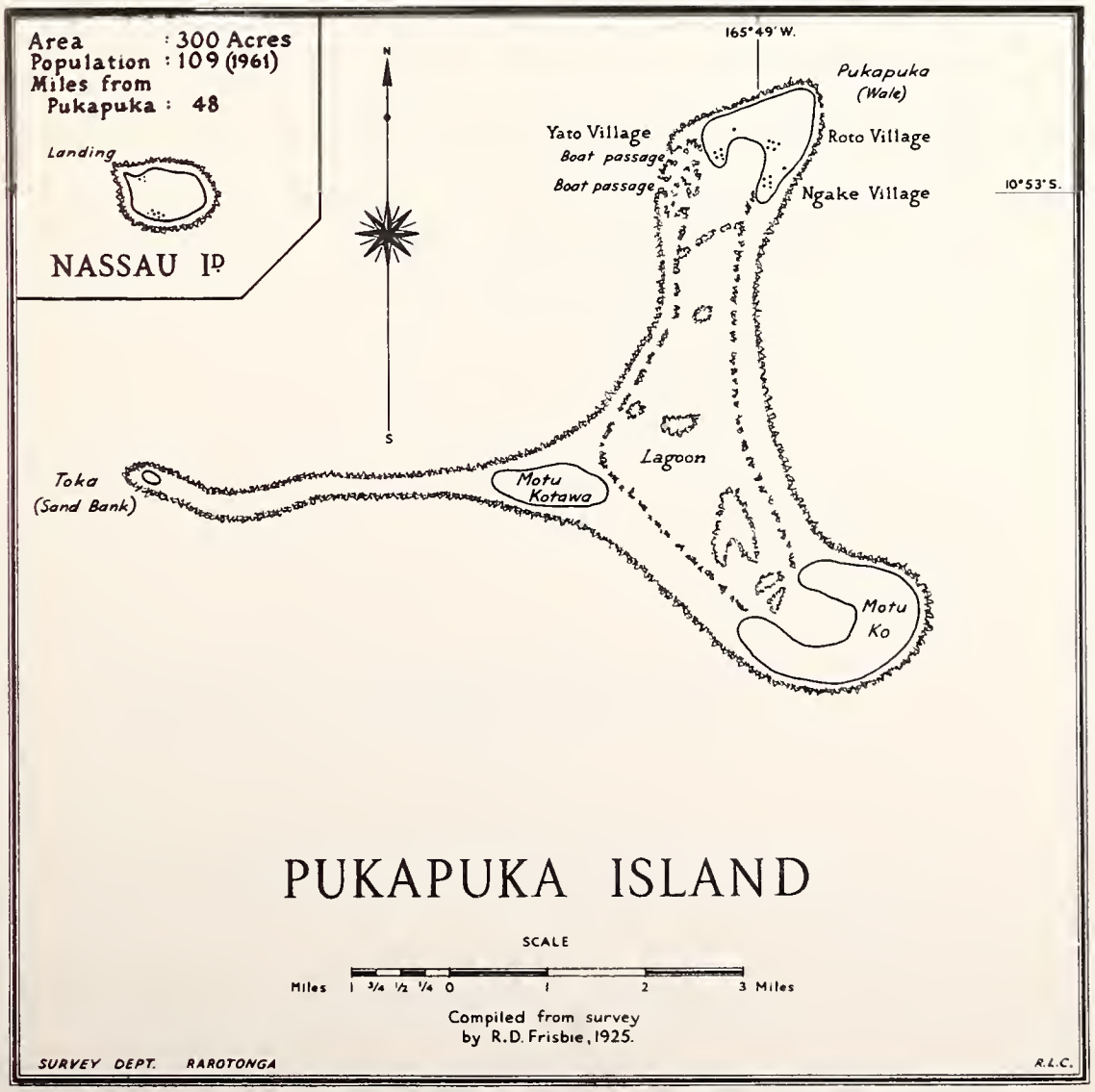
26

THE HEALTH OF TWO GROUPS OF COOK ISLAND MAORIS

Issued by the Medical Research Council of New Zealand
in association with the Medical Statistics Branch
of the Department of Health, Wellington.

1966





MEDICAL RESEARCH COUNCIL OF NEW ZEALAND
AND THE
DEPARTMENT OF HEALTH

THE HEALTH OF TWO GROUPS OF COOK ISLAND MAORIS

Epidemiological Surveys conducted by the Wellington Hospital Medical Unit Survey Team:

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Issued by the Medical Statistics Branch of the Department of Health,
Wellington, New Zealand

R. E. OWEN, GOVERNMENT PRINTER, WELLINGTON, NEW ZEALAND—1966

FOREWORD

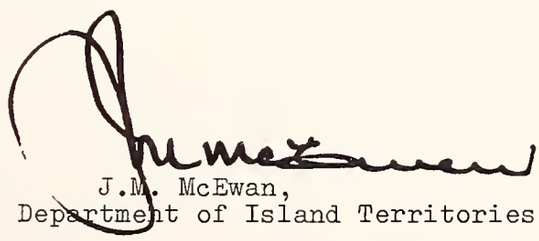
The Report of the health and disease problems in the groups of Cook Island Maoris studied in Rarotonga and Pukapuka brings together a considerable amount of important information. This is of immediate value to those concerned with their health, but will also be of value in the future when the problems are being reassessed.

The differences found between the more isolated Pukapukans and the town-living Rarotongans in a variety of disorders, including high blood pressure, vascular disease and diabetes, suggest the possible part which certain environmental factors may play in their development.

Differences relating to living conditions, diet, habitual salt intake, exercise patterns, stress and extent of 'Westernisation' may all be important and contribute to the patterns of disease observed in the two groups.

The migration of Polynesian people from the South Pacific to New Zealand will continue to bring with it a number of problems in the social, cultural and medical fields, and it is clear that proper studies must be carried out if we are to anticipate these problems in any way.

The present Report represents an important contribution to the general body of knowledge regarding Polynesian people. It also illustrates the way in which different groups can work together to achieve a particular goal.



J.M. McEwan,
Secretary, Department of Island Territories.

TABLE OF CONTENTS

LIST OF STATISTICAL TABLES

LIST OF FIGURES

INTRODUCTION

Surveys carried out in 1962 and 1963 among three groups of New Zealand Maoris living under different environmental conditions have disclosed a number of major health problems. (Prior, 1962; Prior, Rose and Davidson, 1964). These Surveys defined clearly for the first time the extent of such conditions as obesity, diabetes, hyperuricaemia and gout, ischaemic heart disease and hypertension. The New Zealand Maori was shown to be at high risk from these conditions. The extent of manifest ischaemic heart disease and hypertension among the Maori females, of clinical gout in the males and of hyperuricaemia and diabetes in both sexes, suggested that the Maori in New Zealand may well remain at high risk irrespective of long-term material improvement in their environment. The problems raised by these Surveys needed further study and it was decided to carry out similar broadly-based Surveys among Polynesians living outside of New Zealand.

The Cook Islands were chosen because the Maori people there were of the same broad ethnic group as the New Zealand Maori, and also because it was possible there to find contrasting groups living at different stages of material development and exposure to European influence, culture and diet habits.

The Cook Islands have a total population of 19,214 subjects, of which 9,768 live on the main island of Rarotonga. Avarua, the main town and administrative centre for the group has a population of 3,000, and was chosen as the more developed area. The adult study was confined to a sample of subjects who had lived under town conditions in Avarua for ten years or more. Pukapuka, a small, low coral atoll in the Northern Cooks, 730 miles north-west of Rarotonga and 300 miles east of Samoa, has a population of 800 and was chosen as the "isolated" group. There are few more isolated areas in the Pacific, and the validity of this choice was amply confirmed by the detailed observations on the community by the anthropologist attached to the Survey Team. (Beckett 1964). The Pukapukan community had been thoroughly described by Beaglehole (1935) and there has been very little change in the social structures and tempo of living since that time.

Another factor which influenced the choice of Pukapuka as a group to study was the information available from the valuable Survey carried out in 1951 by a New Zealand Medical Research Council team, and published as a New Zealand Health Department Report in 1963. This gave a number of leads regarding the health and disease pattern on the atoll, including a remarkable absence of significant hypertension. (Murphy 1955).

The Pukapukans are still on a subsistence-type economy with a limited cash income of around twelve pounds per person per year derived from copra sold to boats that call two or three times per year. The Rarotongans in Avarua are on a cash economy, with a much higher income and work in regular jobs or as casual labourers when work is available. Many of this group also owned land and were able to grow food for their homes and augment their incomes by selling produce. The group in Rarotonga had very ready access to shops and European-style food, particularly tinned goods. The Pukapukans, with very little buying power and limited available stocks in the stores, were still living largely on their basic diet of fish, taro, coconuts in many and varied forms, with modest supplements of flour, rice and sugar.

The remainder of the Report will deal with the methods, results and conclusions of the Surveys carried out among the adults aged 20 and over in the two areas. The findings in the infants and children will be separately reported.

METHODS

Survey Team:

The Survey Team consisted of two physicians, both of whom had had particular training in cardiology, a paediatrician, a nutritionist, an anthropologist, a biochemist and two technicians responsible for chest radiographs, respiratory function tests and electrocardiograms. Local persons joined the team in both areas as liaison officers, and also helped with interpreting where this was necessary. Local medical officers also rendered continuing help during surveys in both areas.

Liaison:

Meetings were held with the leaders of the communities in both Rarotonga and Pukapuka, and the aims of the surveys explained.

Census:

In Rarotonga a census was made of all people living in a geographical area of the town amounting to about two-thirds of the Borough, and this produced a sample of 480 aged 20 and over who fulfilled the necessary 10-year town residence qualification. In Pukapuka, a census of the whole island was made and all persons on the island were examined. Certain persons, non-permanent residents on Pukapuka, have been excluded from the analysis of the data. School teachers were employed in both areas as census-makers, and their local knowledge and ability to explain the details of the survey was a considerable help.

Once the surveys commenced, participants were given appointments by the liaison officers who also were responsible for registration at the survey centre.

Medical History and Examinations:

Standard forms for recording data were used, and the medical history was taken by the physicians.

The sitting blood pressure was recorded after the history and certain of the anthropometric measurements had been completed. The first reading was discarded and the second recorded. Pressures were recorded to nearest 2 mm. and both 4th and 5th phases of the diastolic pressure were recorded. The participant then stood up for some further anthropometric measurements, and then lay on a couch for the remainder of the examination. The lying blood pressure was recorded twice at the end of the examination. This standard pattern of examination was used in both areas. The lowest lying pressure, taking the 4th phase as diastolic pressure, has been used in analysis of the data.

Laboratory Procedures:

Haemoglobins were carried out using a cyanmethaemoglobin method, packed cell volumes using a microhaematocrit, and urinary sodium estimations with an EEL flame photometer. Serum was separated on day of withdrawal and stored at $-10^{\circ}C$ in a deep freeze, and was maintained at this temperature until analysis in New Zealand. Microfilaria were demonstrated by Knott's method with 1-2 cc. venous blood lysed with water, centrifuged, and the deposit stained with Giemsa stain. (Manson-Bahr, 1960).

Biochemical Estimations:

Serum cholesterols were measured using a modified Abell and Levy (1960) method. Serum uric acid was measured using a non enzymatic Spectro photometric method, and serum in all cases was stored for more than 3 weeks in order to allow non-uric acid chromagen fall-off to occur. (Buchanan, Isdale and Rose, 1965).

Diabetes Detection:

Casual urines were tested for glucose inall participants, and a modified glucose tolerance test carried out in those with glycosuria. 100 g. of glucose was given after an overnight fast, and the fasting and 2-hour blood sugars were estimated by a near-true glucose method. Fluoride was added to the sample bottles to prevent glycolysis. Fasting blood sugar of 120 mg. and over, and a 2-hour level of 130 mg. and over, were taken as being abnormal.

STATISTICAL ANALYSIS

Comparison of groups has been made using T tests. Differences reaching 5% level or less have been classed as significant.

N.S.	= not significant	
5%	significance,	5 chances per 100 of occurring by chance
1%	"	1 chance per 100 " "
0.5%	"	5 chances per 1,000 " "
0.1%	"	1 chance per 1,000 " "

SAMPLES AND PARTICIPATION

Rarotonga

The total sample consisted of 480 subjects, of whom 471 were examined, 2 died, 5 departed for New Zealand and were not available, and 2 declined to take part. The overall participation was therefore 98%.

Pukapuka:

The total population of the island was 796, of whom 360 were under 15 years. There were 379 aged 20 and over who form the basis of this report. 100% participation was achieved.

The details of the samples in the two areas are set out in Table I, together with the percentage falling into each age and sex class.

TABLE I

SAMPLE POPULATION BY AGE AND SEX WITH PERCENTAGE IN EACH AGE CLASS

Age Class	MALES				FEMALES			
	RAROTONGA		PUKAPUKA		RAROTONGA		PUKAPUKA	
	Number	%	Number	%	Number	%	Number	%
20-29	83	34	43	23	83	35	54	28
30-39	45	19	47	26	37	17	47	24.5
40-49	40	16	33	17	41	18	28	15
50-59	40	16	32	17	33	15.5	31	16
60-69	18	8	20	11	21	8	21	11
70 & over	17	7	13	6	13	6.5	10	5.5
Totals	243	100	188	100	228	100	191	100

Combined Total 471 : Rarotonga 379 : Pukapuka

RESULTS AND DISCUSSION OF RESULTS

The findings in the adults aged 20 and over in the two areas will be compared in the following sections. Comments on the findings will be included in these sections. The important difference between the two samples in the two areas lies in the larger numbers in Rarotonga in the 20-29 year class in both sexes. The differences in other age classes are less marked, and results will be presented without any age standardisation.

Anthropometric Findings:

Heights and Weights

The mean heights and weights of the two areas are set out in Tables II, IIa, III and IIIa. It can be seen that the Pukapukan males and females are both shorter and lighter than the Rarotongan males and females. Analysis of the differences observed by tests of significance (t test) are included in the tables.

Extent of Obesity

Triceps and subscapular skin folds were measured with Harpendon skin fold calipers. Mid-arm circumferences were measured with a steel tape in cm.

Calculation of the Relative Weight of each subject, using standard weight for height and age, allows comparison also to be made between the groups. (U.S. Department of Agriculture, 1960). In the Surveys of New Zealand Maoris it was found satisfactory to separate participants into the following four relative weight classes; (1) $\leq$ 100% (thin), (2) 100-119% (normal), (3) 120-139% (obese), and (4) 140% and over (grossly obese). The number and percentage falling into the different Relative Weight classes are set out in Tables IV and V. There are more thin males on Pukapuka than on Rarotonga; 13% of males in Rarotonga were obese, including 5% grossly so, as compared to 7% of obese males in Pukapuka where only one subject out of 188 was classed as grossly obese, and he had extensive elephantiasis. The females present a different picture; 46% of the females in Rarotonga were obese, including 21% of the sample who were grossly obese. In Pukapuka 23% of the females were obese, but only 2% were grossly obese. Females more than 3 months pregnant have been excluded from these analyses. See Fig. 1.

The remarkable extent of obesity in the Rarotongan females, as compared to that found in the Rarotongan males and in the Pukapukans, would appear to have its basis in a continuing positive calorie balance related to marked inactivity. By the time they have reached gross obesity calorie intake of the Rarotongan women was found to be moderate rather than excessive but, as a group, they were clearly inactive. Small tidy houses requiring little housework, and willing younger relatives to do much of the harder work, are contributing features.

Important reasons why gross obesity was virtually absent among the Pukapukans include the fact that incomes are more limited, food is in shorter supply, and the women have moderate and at times heavy physical commitments and are still responsible for growing and tending the taro. It is significant that obesity was notably more frequent among the wives of the few Pukapukan men who were on a regular salary, such as school teachers, radio operators and policemen, which gave the household considerable extra buying power. Of 20 wives whose husbands were on salaries, 14 were classed as obese, while there were only 25 out of 148 no extra salary wives classed as obese. This difference is highly significant at the 0.001% level and could be one of the keys to the problem of Polynesian obesity.

TABLE II

MEAN HEIGHTS OF MALES

in inches

MALES	RAROTONGA	PUKAPUKA	P.
20-29			
No.	83	43	
Mean	67.67	66.86	N.S.
S.D.	2.44	2.55	
30-39			
No.	45	47	
Mean	67.87	66.28	0.1%
S.D.	2.27	2.10	
40-49			
No.	40	33	
Mean	68.22	65.17	0.1%
S.D.	2.42	2.24	
50-59			
No.	40	32	
Mean	66.96	65.42	0.5%
S.D.	2.18	1.80	
60-69			
No.	18	20	
Mean	66.83	64.7	0.1%
S.D.	2.42	1.05	
70 & over			
No.	17	13	
Mean	66.44	64.30	0.5%
S.D.	1.66	1.78	

TABLE II a

MEAN HEIGHTS OF FEMALES

in inches

FEMALES	RAROTONGA	PUKAPUKA	P.
20-29			
No.	82	54	
Mean	63.67	62.23	0.1%
S.D.	1.67	2.00	
30-39			
No.	37	47	
Mean	63.37	62.30	1.0%
S.D.	2.35	1.94	
40-49			
No.	41	28	
Mean	63.35	61.94	0.5%
S.D.	2.15	1.47	
50-59			
No.	33	31	
Mean	62.56	61.56	5.0%
S.D.	2.05	2.21	
60-69			
No.	21	21	
Mean	63.04	60.66	0.5%
S.D.	2.07	2.37	
70 & over			
No.	13	10	
Mean	60.65	59.25	N.S.
S.D.	2.25	2.48	

TABLE III

MEAN WEIGHTS IN MALES

in pounds

MALES	RAROTONGA	PUKAPUKA	P.
20-29			
No.	83	43	
Mean	161.8	151.9	5.0%
S.D.	29.0	16.3	
30-39			
No.	45	47	
Mean	166.7	155.0	5.0%
S.D.	24.7	21.6	
40-49			
No.	40	33	
Mean	179.5	151.8	0.1%
S.D.	33.0	19.8	
50-59			
No.	40	32	
Mean	163.0	159.3	N.S.
S.D.	26.2	26.7	
60-69			
No.	18	20	
Mean	169.3	157.0	N.S.
S.D.	34.1	18.3	
70 & over			
No.	17	13	
Mean	153.4	140.8	N.S.
S.D.	25.6	15.8	

TABLE IIIa

MEAN WEIGHTS IN FEMALES

in pounds

FEMALES	RAROTONGA	PUKAPUKA	P.
20-29			
No.	76	47	
Mean	150.3	136.4	0.1%
S.D.	24.7	15.8	
30-39			
No.	31	43	
Mean	170.5	149.7	0.5%
S.D.	34.7	24.7	
40-49			
No.	40	27	
Mean	188.9	149.3	0.1%
S.D.	43.6	25.4	
50-59			
No.	33	31	
Mean	186.6	148.8	0.1%
S.D.	49.4	30.1	
60-69			
No.	21	21	
Mean	180.0	132.8	0.5%
S.D.	57.7	24.3	
70 & over			
No.	13	10	
Mean	138.5	106.8	$< 5\%$
S.D.	38.3	25.0	

TABLE IV

WEIGHT CATEGORIES AT DIFFERENT AGES - NUMBERS AND PERCENTAGES

MALES	RAROTONGA		PUKAPUKA	
Age and Relative Weight Class	Number	%	Number	%
20-29				
1 thin	18	22	14	33
2 normal	53	64	28	65
3 obese	7	8	1	2
4 grossly obese	5	6	.	.
Total in group:	83	100	43	100
30-39				
1 thin	14	31	21	45
2 normal	26	58	22	47
3 obese	4	9	4	8
4 grossly obese	1	2	.	.
Total in group:	45	100	47	100
40-49				
1 thin	15	37	18	55
2 normal	15	37	14	42
3 obese	7	18	1	3
4 grossly obese	3	8	.	.
Total in group:	40	100	33	100
50-59				
1 thin	19	48	17	53
2 normal	20	50	11	34
3 obese	.	.	3	9
4 grossly obese	1	2	1	3
Total in group:	40	100	32	99
60-69				
1 thin	8	44	7	35
2 normal	8	44	11	55
3 obese	2	11	2	10
4 grossly obese	.	.	.	.
Total in group:	18	99	20	100
70 & over				
1 thin	12	70	8	62
2 normal	4	24	5	38
3 obese	.	.	.	.
4 grossly obese	1	6	.	.
Total in group:	17	100	13	100

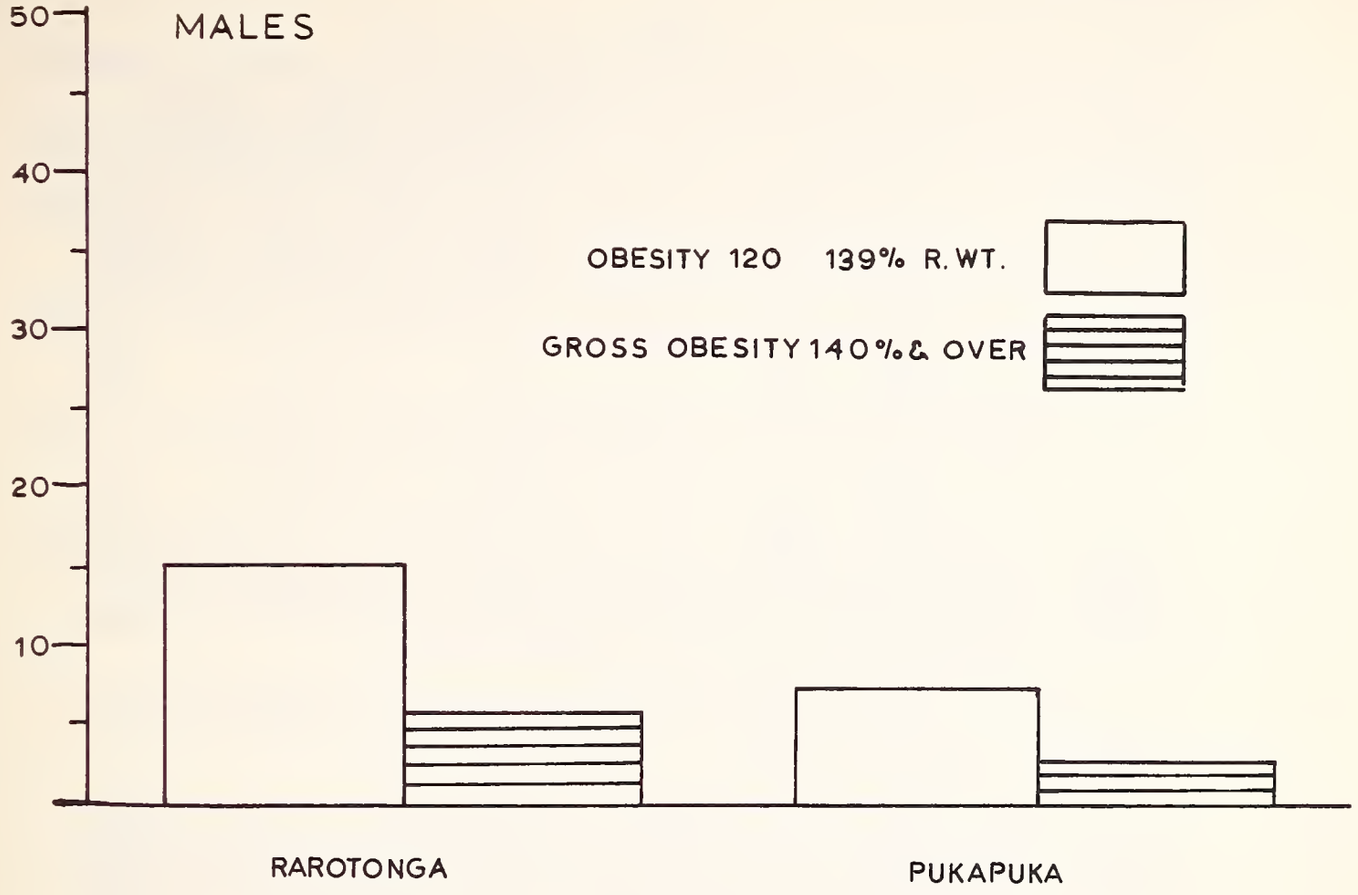
TABLE IVa

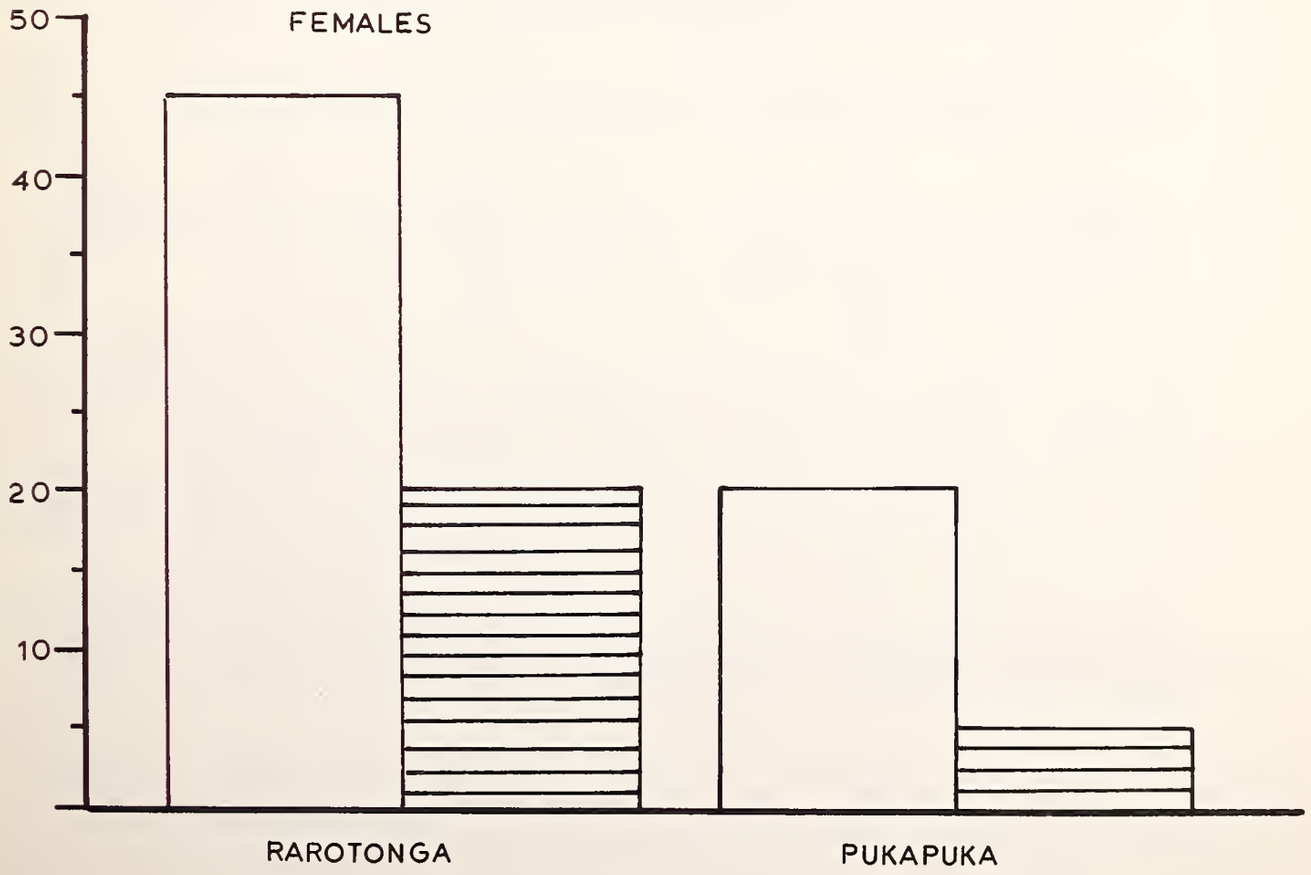
WEIGHT CATEGORIES AT DIFFERENT AGES - NUMBERS AND PERCENTAGES

FEMALES	RAROTONGA		PUKAPUKA	
Age and Relative Weight Class	Number	%	Number	%
20-29				
1 thin	13	17	9	19
2 normal	33	44	30	64
3 obese	21	28	8	17
4 grossly obese	8	11	.	.
Total in group:	75	100	47	100
30-39				
1 thin	4	14	12	28
2 normal	11	38	15	35
3 obese	9	31	15	35
4 grossly obese	5	17	1	2
Total in group:	29	100	43	100
40-49				
1 thin	4	10	9	35
2 normal	12	30	9	35
3 obese	10	25	7	26
4 grossly obese	14	35	1	4
Total in group:	40	100	26	100
50-59				
1 thin	6	18	12	39
2 normal	10	30	13	42
3 obese	5	15	5	16
4 grossly obese	12	36	1	3
Total in group:	33	99	31	100
60-69				
1 thin	5	24	15	71
2 normal	6	29	5	24
3 obese	6	29	1	5
4 grossly obese	4	19	.	.
Total in group:	21	101	21	100
70 & over				
1 thin	9	69	8	80
2 normal	1	8	1	10
3 obese	2	15	1	10
4 grossly obese	1	8	.	.
Total in group:	13	100	10	100

FIGURE 1

THE EXTENT OF OBESITY AND GROSS OBESITY IN MALES AND FEMALES





Cardio-vascular Findings:

Blood Pressure

The mean systolic and diastolic blood pressures are detailed in Tables V and Va. It can be seen that the Rarotongans of both sexes show an increase in blood pressure with age, and that both systolic and diastolic pressures in the females exceed those in the males from the fourth decade. There is very little change in mean blood pressures with age in the Pukapukans, and no significant difference between the sexes. The extent of the difference between the two groups can be clearly seen in Figure 2. It is recognised that comparisons can be made more effectively using frequency distribution curves, and these are shown in Figures 3 and 4. For purpose of analysis and comparison it has been found valuable to take 160/95 and over as representing significant hypertension, and to compare single and grouped age classes.

Taking subjects aged 40 years and over, it was found that in Rarotonga 28% of the males and 47% of the females came into this category, as compared to 3% of the males and 7% of the females in Pukapuka.

The finding of Grade 2 hypertensive fundal changes in 14 of the 32 males and 25 of the 51 females with blood pressures of 160/95 and over in Rarotonga, while no such changes were observed in the Pukapukans, is confirmatory evidence that the hypertension was significant in the Rarotongan subjects. Electrocardiograph and X-ray evidence of cardiac hypertrophy was present in a number of these cases.

The striking differences observed between people of the same ethnic group raises a number of possibilities. Genetic, environmental and dietary factors were considered.

It is believed by the local inhabitants that the atoll of Pukapuka was involved in a devastating tidal wave around 300 years ago with only 12 survivors. It is possible that the genetic factor contributing to hypertension was not present in these survivors, and this could explain the absence of the condition among their descendants. The absence of hypertension among other Pacific Island groups, Micronesians in the Gilbert Islands, Melanesians on the island of Gau in the Fiji group and in New Guinea Highlanders, has been shown by Maddocks (1961), and favours environmental, rather than genetic, factors.

The temperature in Pukapuka was only 3-6 degrees higher than in Rarotonga, while the humidity was 6-8% higher. It is considered unlikely that this could account for the blood pressure differences.

Differences in heights and weights are present and could be important. The extent of gross obesity in the Rarotongan females is likely to be contributing to the extent of hypertension found among them. It is unlikely to be due to the small and variable differences in arm circumferences which were found. See Table VI.

The social pressures and changes occurring in the more westernised Rarotongan group may be factors of importance. The measurement and defining of these in groups and individuals is not easy, but it is quite certain that social change is occurring slowly on Pukapuka, and Pukapukans are largely removed from the cultural problems facing Polynesians living in bi-cultural communities such as New Zealand. The Maoris are the majority group in Rarotonga and, while many have come in from outer islands and therefore lack the security of owning land, this does not seem to be associated with recognisable signs of stress.

The men in the 40-59 age group in Rarotonga were studied in detail by the anthropologist, but no differences in domestic situation, divorce rate, alcohol intake or crime rate were found between those with, and those without, significant hypertension.

TABLE V

MEAN BLOOD PRESSURES (mm Hg) IN MALES

Age Class	SYSTOLIC			DIASTOLIC		
	Rarotonga	Pukapuka	P.	Rarotonga	Pukapuka	P.
20-29						
No.	83	43		83	43	
Mean	132.1	122.2	0.1%	84.5	76.0	0.1%
S.D.	11.7	12.9		8.9	8.8	
30-39						
No.	45	47		45	47	
Mean	133.1	121.6	0.1%	85.2	76.7	0.1%
S.D.	11.9	13.1		10.2	8.5	
40-49						
No.	40	33		40	33	
Mean	146.2	120.2	0.1%	97.5	81.1	0.1%
S.D.	21.5	12.4		14.6	9.1	
50-59						
No.	40	32		40	32	
Mean	146.4	126.8	0.1%	94.0	79.8	0.1%
S.D.	23.5	14.8		10.8	9.6	
60-69						
No.	18	20		18	20	
Mean	153.0	127.6	0.5%	93.4	79.2	0.1%
S.D.	30.0	19.2		13.2	9.3	
70 & over						
No.	17	13		17	13	
Mean	155.9	117.5	0.5%	92.4	71.2	0.1%
S.D.	32.7	22.1		16.6	13.6	

TABLE Va

MEAN BLOOD PRESSURES (mm Hg) IN FEMALES

Age Class	SYSTOLIC			DIASTOLIC		
	Rarotonga	Pukapuka	P.	Rarotonga	Pukapuka	P.
20-29						
No.	83	54		83	54	
Mean	121.1	112.2	0.1%	78.5	70.9	0.1%
S.D.	12.1	12.3		10.4	7.9	
30-39						
No.	37	47		37	47	
Mean	131.5	118.3	0.1%	84.0	75.4	0.1%
S.D.	16.5	14.1		11.9	8.7	
40-49						
No.	41	28		41	28	
Mean	152.2	122.6	0.1%	97.6	76.5	0.1%
S.D.	26.7	17.6		16.4	11.6	
50-59						
No.	33	31		33	31	
Mean	170.2	134.2	0.1%	102.9	80.5	0.1%
S.D.	38.2	20.5		17.6	11.2	
60-69						
No.	21	21		21	21	
Mean	174.8	127.7	0.1%	105.6	78.2	0.1%
S.D.	35.1	15.8		18.7	10.2	
70 & over						
No.	13	10		13	10	
Mean	172.9	125.4	0.5%	98.5	67.8	0.1%
S.D.	36.8	33.0		17.4	15.0	

TABLE VI

MEAN ARM CIRCUMFERENCE IN CMS:

Comparison by Age and Sex for Rarotongan and Pukapukan MALES

AGE CLASS	RAROTONGA	S.D.	PUKAPUKA	S.D.
20-29	29.57	3.17	30.21	1.89
30-39	30.67	2.96	31.19	2.69
40-49	31.60	4.19	31.15	2.43
50-59	29.93	2.96	31.54	2.68
60-69	29.78	3.76	31.40	2.16
70 & over	27.53	3.72	27.54	2.58

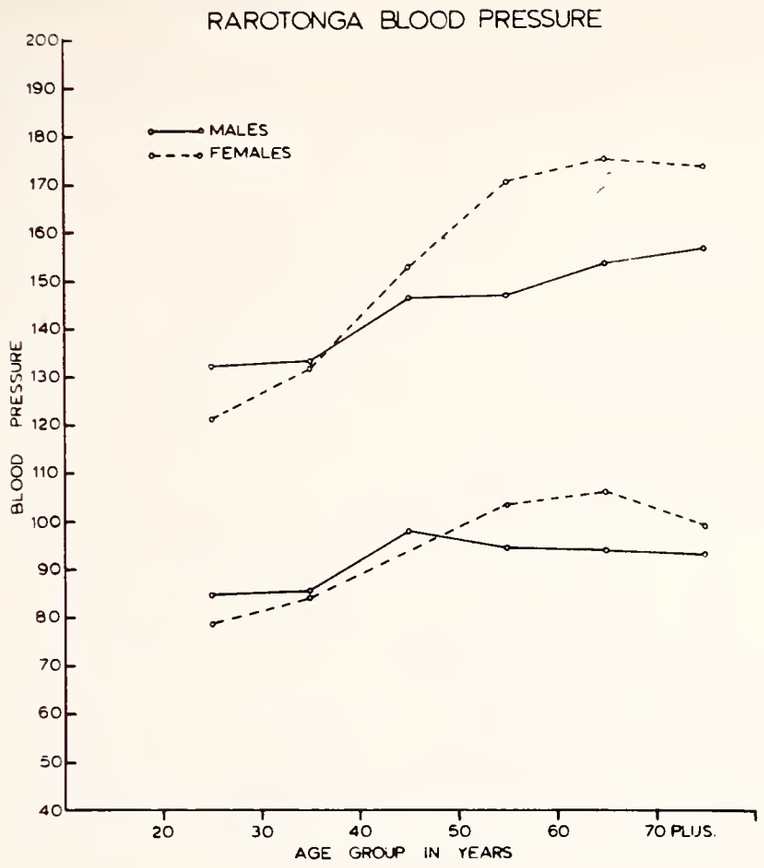
MEAN ARM CIRCUMFERENCE IN CMS:

Comparison by Age and Sex for Rarotongan and Pukapukan FEMALES

AGE CLASS	RAROTONGA	S.D.	PUKAPUKA	S.D.
20-29	28.03	2.83	29.55	2.70
30-39	30.67	3.82	31.69	3.38
40-49	33.09	5.24	32.22	3.63
50-59	32.69	5.57	31.38	3.60
60-69	31.39	6.54	29.33	3.32
70 & over	26.69	4.07	24.7	3.17

FIGURE 2

MEAN SYSTOLIC AND DIASTOLIC BLOOD PRESSURES IN mmHg.



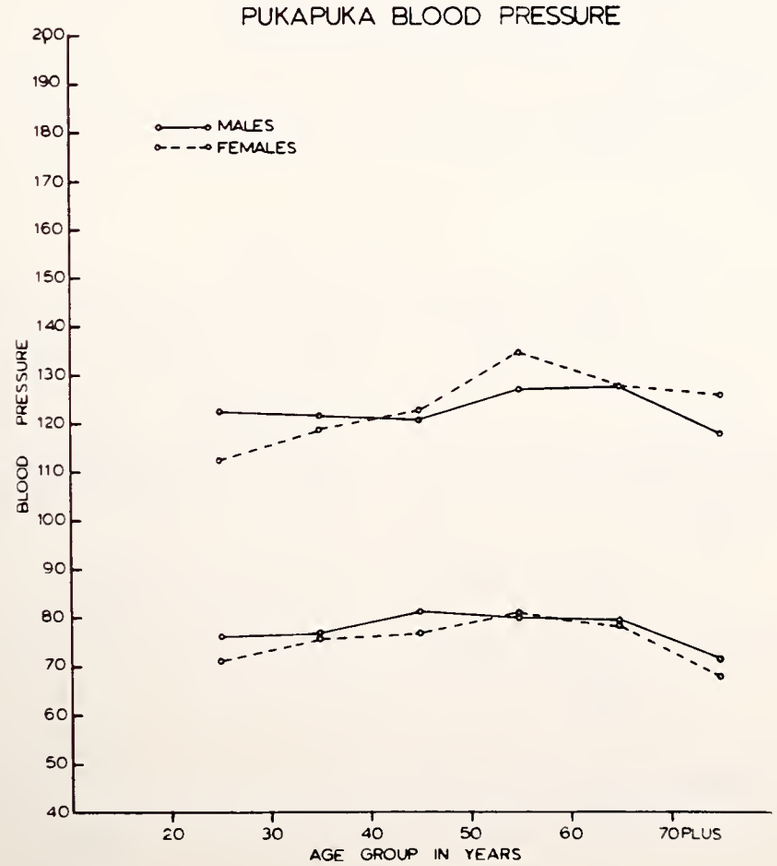
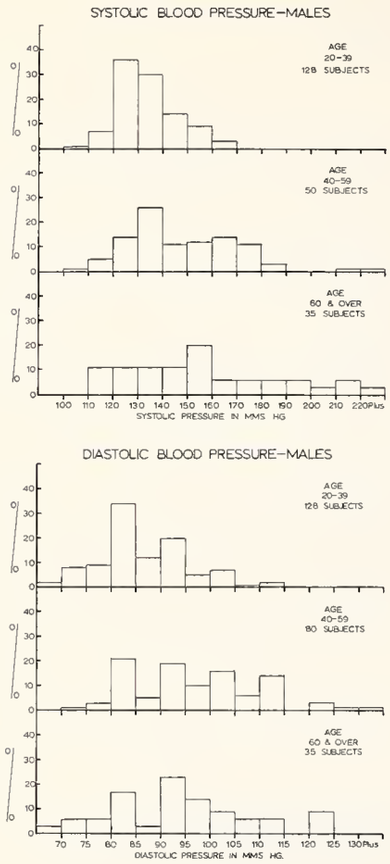


FIGURE 3

FREQUENCY DISTRIBUTIONS OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURES IN AGE CLASSES IN MALES

RAROTONGA



PUKAPUKA

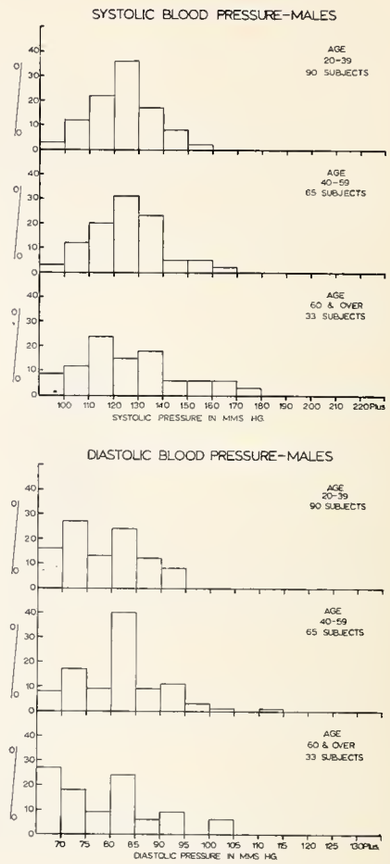
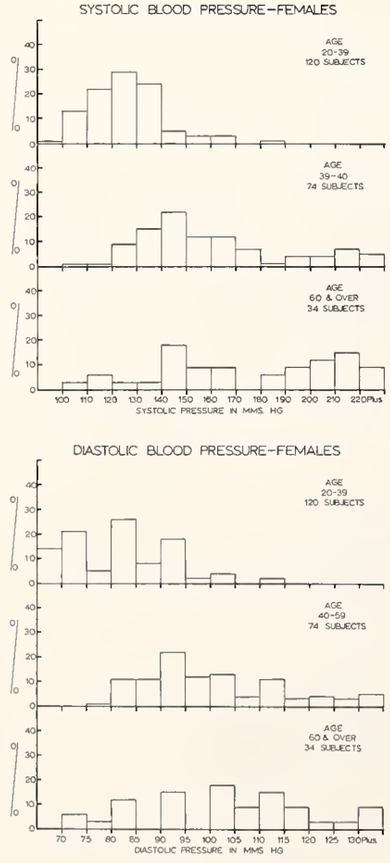


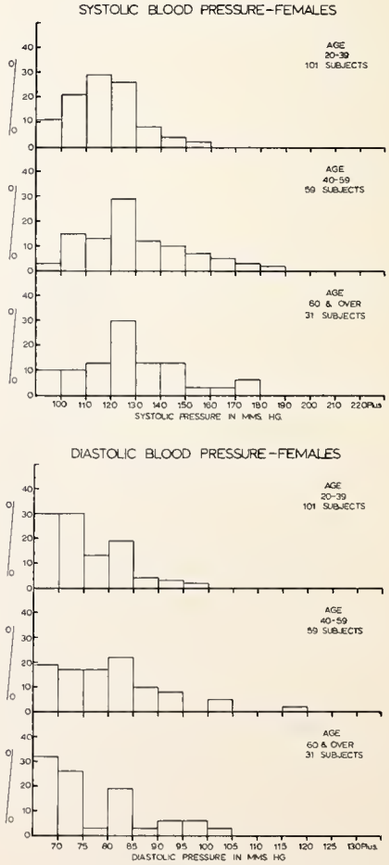
FIGURE 4

FREQUENCY DISTRIBUTIONS OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURES IN AGE CLASSES IN FEMALES

RAROTONGA



PUKAPUKA



Diet, Salt Intake and Hypertension

The diet pattern of the two groups showed many contrasts, and will be described in detail in the section on diet. The difference in salt appetite between the groups was quite remarkable, and was defined by the following methods:

1. Assessment of intake by nutritionist;
2. Measurement of casual urinary sodium concentration in participants in both areas;
3. Collection of two consecutive 24-hour urine samples from a large sample of the participants.

It was found that the Pukapukans added virtually no salt to their food. This was in marked contrast to the Rarotongans, who used salt and salty tinned corned meats much more liberally.

The frequency distribution of the casual urinary sodiums are shown in Figures 5 and 6. It can be seen that in the males, 60% of Pukapukans had concentrations below 75 mEq./litre and 4% above 150mEq./litre, as compared to 17% and 34% in Rarotongan males.

In the females, 59% of Pukapukans had concentrations below 75 mEq./litre and 3.5% above 150mEq./litre, as compared to 20% and 24% in the Rarotongan females. The mean 24-hour sodium outputs in the two areas are shown in Table VII and, again, the differences can be clearly seen. A comparison of the serum sodium levels in samples of 75 subjects from the two islands has not shown any significant difference. The serum sodium levels in the whole Rarotongan sample were analysed, and failed to show any significant difference between hypertensives and non-hypertensives within the same population sample.

A relationship between salt intake and hypertension has been known for many years, and has been put forward by Dahl (1961) as an important cause for the difference observed between groups in population studies. The data presented gives further support to the hypothesis that long-continued high or low salt intake in groups of people will influence the blood pressure pattern observed. Further work, including blood volume and sodium space studies may throw further light on this problem. The genetic susceptibility to sodium has been shown in rat-breeding experiments by Dahl and his co-workers, and may explain why only certain subjects on a similar sodium intake within a given population develop hypertension.

TABLE VII

MEAN 24-hour URINARY SODIUM OUTPUTS IN mEq.

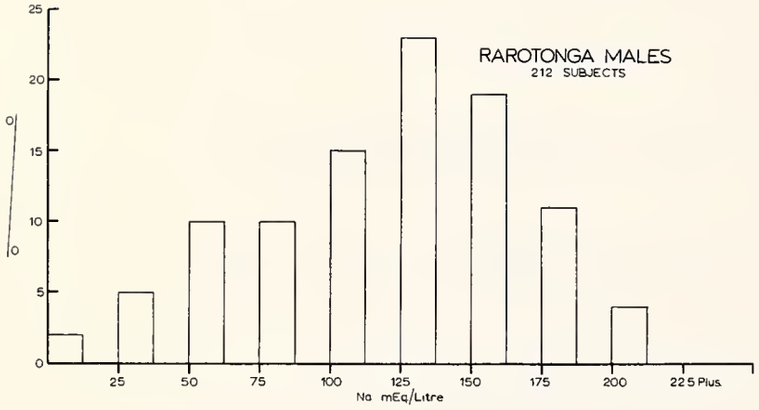
ALL AGE GROUPS COMBINED

	MALES			FEMALES		
	Number	Mean in mEq.	S.D.	Number	Mean in mEq.	S.D.
Rarotonga	50	115	67	16	103	33
Pukapuka	40	62	36	25	64	36

FIGURE 5

FREQUENCY DISTRIBUTION OF CASUAL URINARY SODIUM CONCENTRATIONS IN MALES

RAROTONGA



PUKAPUKA

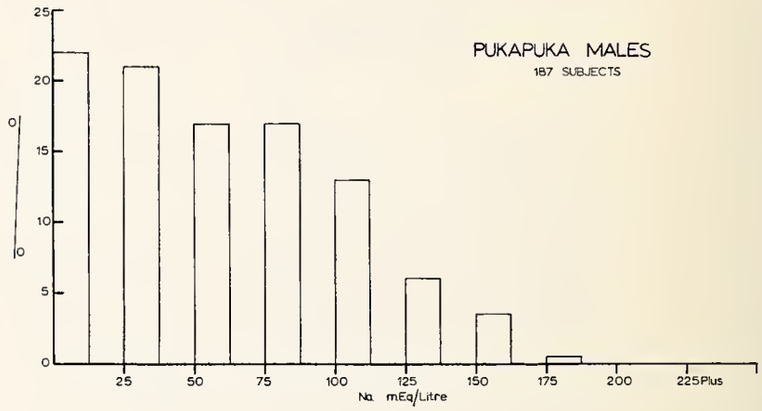
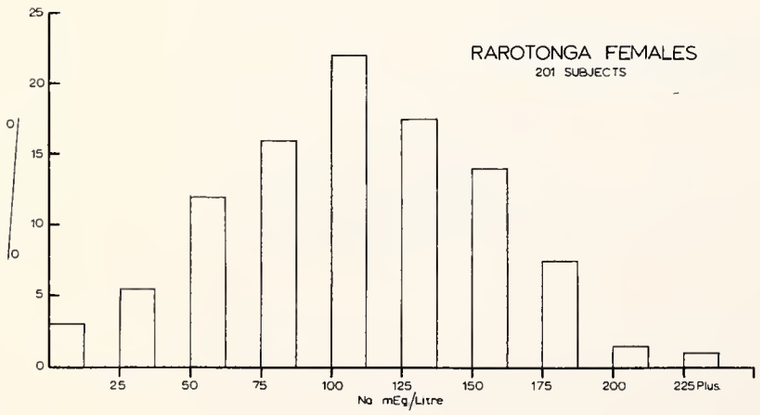


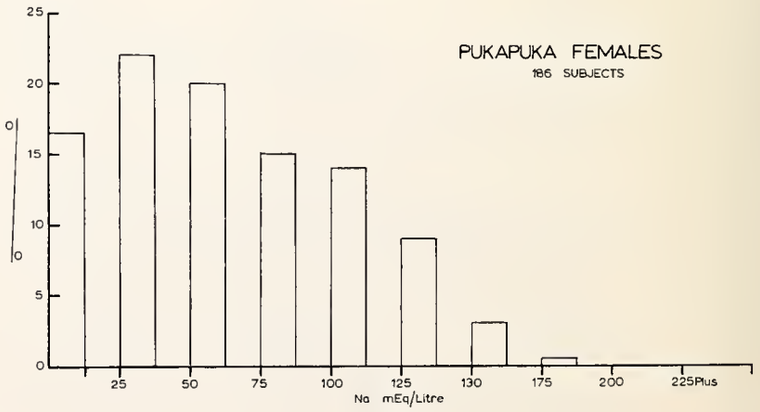
FIGURE 6

FREQUENCY DISTRIBUTION OF CASUAL URINARY SODIUM CONCENTRATIONS IN FEMALES

RAROTONGA



PUKAPUKA



Chest Pain and Ischaemic Heart Disease

The questionnaire devised by the London School of Hygiene and Tropical Medicine was used in both surveys.

It soon became apparent in Rarotonga that chest pain was a common symptom. It was found to occur on exertion, particularly hurrying, but also with lifting, twisting movements, on carrying objects, and at times would come on at rest and in bed. The pain was described as a tightness in some but, in others, was sharp and stabbing. It was associated with pain in the upper dorsal region in some subjects.

Systematic palpation of the dorsal spine was introduced as part of the routine examination at an early stage of the surveys, and many of those complaining of chest pain were found to have local tenderness in the upper dorsal spine, and over their upper costal cartilages in a smaller number. Pressure over the spine reproduced the chest discomfort in some of the subjects. This condition was thought to be some form of spinal radicular syndrome. It was found to be still more common amongst the Pukapukans, and had been recognised as an entity causing quite severe symptoms on occasions by the local people, the medical officer, and also by the Maori "medical" man, who treated it by vigorous back manipulation and massage. The remarkable prevalence of this condition led to difficulty in clearly separating those with manifest ischaemic heart disease.

Angina was diagnosed in 7 males and 8 females in Rarotonga, as compared to 3 males and 2 females in Pukapuka.

In Rarotonga, 3 of the males and 7 of the females were obese, relative weights $>$ 120%, while significant hypertension was present in 1 male and in 6 of the females. Six of the 7 males had diastolic hypertension with pressures above 95 mm. Hg. Three also had dorsal spine tenderness. The E.C.G. showed left ventricular hypertrophy in 1 subject, right bundle branch block in another, and non-specific T-wave abnormalities in 4.

In Pukapuka, only 1 had diastolic hypertension, and 4 of the 5 had upper dorsal spine tenderness, with pain also felt on lifting. Their histories were considered to be consistent with angina. The E.C.G's. were normal.

The findings suggest that atherosclerosis and its complications are occurring more frequently among those in Rarotonga than in Pukapuka. This is supported also by the fact that only one person gave a history of a transient stroke in Pukapuka, as compared to 3 females found to have had a frank hemiparesis in Rarotonga. One of these also had hypertension, and one was a diabetic with angina.

The much greater prevalence of skeletal non-cardiac pain among the Pukapukans raises a number of questions. Copra cutting, paddling canoes and digging in taro beds are all occupations which involve considerable spinal movement, and could be contributing factors. It is possible that the very high rate of filariasis is also a factor of importance in some way predisposing to this condition.

Significant Valvular Disease

Significant murmurs were uncommon in the males in both islands. There were 2 on Pukapuka, one rheumatic aortic stenosis and incompetence, and one aortic ejection murmur, as compared to 4 on Rarotonga, 2 with aortic incompetence, and 2 with aortic systolic ejection murmurs. The pattern and frequency of murmurs was strikingly different in the females.

There were 16 females with significant murmurs in Rarotonga, as compared to 3 in Pukapuka. In Rarotonga, rheumatic heart disease with mitral or mixed mitral and aortic involvement occurred in 6. Aortic incompetence was present in 3, 2 of whom had hypertension. Seven had significant aortic ejection murmurs, suggesting varying degrees of aortic narrowing. Two of these were in their 50's, and the remaining 5 were in their 70's. Three of the 7 had significant hypertension, the remainder were normotensive.

In Pukapuka, there were 2 females with mitral incompetence, 1 of whom was an elderly woman of 74 with a large nodular thyroid and atrial fibrillation and heart failure, who was presumed to have thyroid heart disease. There was only one female with a significant aortic systolic ejection murmur.

The very low prevalence of rheumatic valvular disease in Pukapuka is presumably due to their isolated geographical state and infrequent exposure to streptococcal infections, as compared to the Rarotongans. The greater prevalence among females, as compared to males, in Rarotonga suggests a greater female susceptibility,, which has also been found in the New Zealand Maori surveys. The striking difference in prevalence of aortic systolic ejection murmurs raises several interesting possibilities which relate to the possible etiology of this condition. The higher prevalence of definite rheumatic valvular disease in Rarotonga would support the hypothesis that these murmurs were rheumatic in origin, and ran a benign slow course causing murmurs to appear only in the older age groups. If these murmurs are on an atherosclerotic basis, possibly aggravated by hypertension, then again the relative absence of manifest atherosclerosis and hypertension among the Pukapukans could explain the difference. This may well be the most probable explanation. It is certain that they are not simply due to changes associated with ageing as such, as the groups are quite comparable in their age distribution. It is unlikely that a difference in the prevalence of minor congenital abnormalities of the aortic valve could explain the findings, as such murmurs were noted only in people aged 50 and over.

The most probable explanation of the difference in aortic ejection murmur is considered to be the lower prevalence of manifest atherosclerosis and hypertension among the Pukapukans.

Pulse Rates

Pulse rates were recorded in each subject at a standard stage of the medical examination, and so are comparable. The frequency distributions of the pulse rate in the two groups are set out in Table VIII. Bradycardia was much more common in both Pukapukan males and females than in the Rarotongans, 52% of males and 28% of females on Pukapuka having pulse rates below 70 per minute, as compared to 28% of the males and 12% of the females in Rarotonga. The cause of this difference, and the contribution it may be making to some of the other circulatory differences between the groups, such as blood pressure levels, can be questioned. Certainly, it could be used as evidence of the infrequency of psychical stress factors in the Pukapukans.

TABLE VIII

DISTRIBUTION OF PULSE RATES IN TWO GROUPS

MALES	60	70	80	90	100	110	120
RAROTONGA							
N = 242	5	50	83	70	26	7	1
%	2	20	34	29	11	2.5	0.5
PUKAPUKA							
N = 186	19	76	51	33	5	1	1
%	10	42	27	17.5	2.5	0.5	0.5
FEMALES							
RAROTONGA							
N = 227	1	25	64	85	25	18	6	3
%	0.5	11	28	37	11	8	2.5	1
PUKAPUKA							
N = 191	7	47	61	52	20	3	1
%	3	25	32	27	10	2.5	0.5

1. Cricket teams, Pukapuka.

2. Girl carrying taro, Pukapuka.

3. Preparing the earth-oven (umu). Pukapuka.

4. Bread (salt free) baked in umu, Pukapuka.

5. Family group, Pukapuka.

6. Man making pandanus roof thatch, Pukapuka.

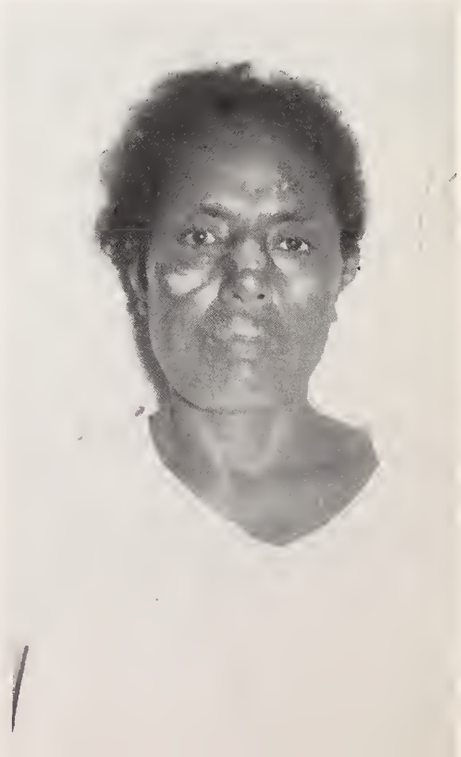
1. Registration desk, Pukapuka.

2. Measuring subscapular skin fold with Harpendon skin fold calipers.

3. Retinal photograph being taken with a Kowa hand-held retinal camera.

4. Laboratory, Pukapuka, showing flame photometer, spectrophotometer and other equipment.

5. Elephantiasis, Pukapuka, in middle-aged male.



6. Discoid lupus erythematosis in a Pukapukan woman.

Haematological Findings

The haemoglobins and packed cell volumes of the two groups were measured, and the mean values and distribution for the haemoglobins, and the distribution of the packed cell volumes are detailed in Tables IX, X and XI.

The mean haemoglobin levels and packed cell volumes are lower for both sexes on Pukapuka than in Rarotonga.

There were more cases of frank anaemia on Pukapuka, and a number of these were iron-deficient with a good response to oral and intramuscular iron. The lower haemoglobin in the group as a whole requires explanation, and could be dietary or related to blood loss from intestinal parasites. These were not sought for specifically in the adults, but were not found to be a major problem in the children, and are not regarded as the cause of the findings. Assessment of the diet indicated that the overall iron intake was low in the Pukapukans, as compared to the Rarotongans where the liberal use of tinned corned beef provided an important iron source. One case only of megaloblastic anaemia, Addisonian in type, was diagnosed in the two groups, a male Rarotongan aged 84; the remainder were regarded as iron-deficient. The extent of the anaemia can best be seen from the distribution graph, where the number below 12 g. can be compared in the two groups - Table X.

The pulse rate and haematological data have been included in this section because of the particular relevance they may have to the differences in the cardiovascular findings between the two groups.

TABLE IX

MEAN HAEMOGLOBIN VALUES BY AGE AND SEX IN TWO GROUPS

In GM/100ML

Age Class	MALES			FEMALES		
	Rarotonga	Pukapuka	P.	Rarotonga	Pukapuka	P.
20-29						
No.	83	43		83	54	
Mean	14.79	13.40	0.1%	12.79	11.55	0.1%
S.D.	1.05	1.21		1.24	1.12	Ex.
30-39						
No.	45	47		37	47	
Mean	14.86	13.50	0.1%	13.04	11.60	0.1%
S.D.	1.06	1.04		1.15	1.24	
40-49						
No.	40	33		41	28	
Mean	14.67	13.06	0.1%	13.23	11.50	0.1%
S.D.	1.59	1.17		1.52	0.87	
50-59						
No.	40	32		33	31	
Mean	14.56	12.68	0.1%	13.83	11.85	0.1%
S.D.	1.47	0.95		1.48	0.94	
60-69						
No.	18	20		21	21	
Mean	14.95	12.62	0.1%	14.29	11.42	0.1%
S.D.	1.23	1.24		1.40	0.90	
70 & over						
No.	17	13		13	10	
Mean	13.74	11.50	0.5%	12.72	10.65	0.1%
S.D.	1.14	1.23		1.04	0.71	

TABLE X

DISTRIBUTION OF HAEMOGLOBINS IN GM/100 ML.

MALES	8	9	10	11	12	13	14	15	16	17	18	Hb in gm
RAROTONGA												
243	1	1	.	4	13	43	83	61	24	10	2	
%	.5	.5	.	1.5	5.5	18	34	25	10	4	1	74% > 14 gm
PUKAPUKA												
188	1	.	8	31	46	64	27	10	1	.	.	
%	.5	.	4	16.5	24.5	34	14.5	5.5	.5	.	.	20.5% > 14gm

FEMALES	8	9	10	11	12	13	14	15	16	17	18	
RAROTONGA												
228	.	3	11	26	58	63	45	16	3	3	.	
%	.	1	5	11	25.5	27.5	20	7.0	1.0	1.0	.	82% > 12 gm
PUKAPUKA												
191	.	14	49	58	56	14	2	.	.	.	.	
%	.	7	25.5	30	29	7.5	1	.	.	.	.	37.5% > 12gm

TABLE XI

DISTRIBUTION OF PACKED CELL VOLUMES

MALES	30	35	40	45	50	in mm
RAROTONGA						
243	1	2	17	129	86	8	
%	.5	1	7	53	35	3	38% > 45 mm
PUKAPUKA						
188	1	3	65	107	12	.	
%	.5	1.5	34.5	56.5	6.5	.	6.5% > 45 mm

FEMALES	30	35	40	45	50	in mm
RAROTONGA						
227	.	15	105	99	7	1	
%	.	6.5	46	44	3	.5	47.5% > 40 mm
PUKAPUKA						
191	4	41	120	26	.	.	
%	2	21	63	14	.	.	14% > 40 mm

Metabolic Disorders

Hyperuricaemia and Gout

A history consistent with acute episodes of gout was obtained from 10 males on Pukapuka, prevalence 5.3% and 6 males in Rarotonga, prevalence 2.5%. The serum uric acid was above 7 mg. in 9 of the 10 in Pukapuka, and in all of the 6 in Rarotonga. No females cases were found.

Cases were diagnosed on a basis of a classical history of acute episodes involving the big toe or toes with redness and swelling. One man on Pukapuka was observed during an acute attack of podagra, which responded dramatically to colchicine, and a further one was seen with widespread joint involvement and tophi of his ears. The mean serum uric acid levels in both sexes for the two groups are detailed in Table XII and Figure 7. The frequency distribution of serum uric acids is shown in Table XIII and Figure 8, and it can be seen that on Pukapuka, 48% of the males have levels above 7 mg., as compared to 44% on Rarotonga. In the females, 48% of those on Pukapuka had levels above 6 mg.% as compared to 43% on Rarotonga.

The difference in prevalence of clinical gout in the males is interesting, particularly as the Pukapukan males were lighter, were taking no alcohol, and were on a lower calorie intake.

They were, however, on a higher overall fat intake than the Rarotongans, deriving 35% of their calories from fat as compared to 27% in the Rarotongans. The fact that 75% of the fat calories in the Pukapukans were from the coconut, a highly saturated source, must also be considered as both the quantity and the type of fat may alter renal handling of uric acid.

Another explanation could be that the Pukapukans have a greater concentration of the genetic factors contributing to hyperuricaemia and gout in individuals due to inbreeding within their small isolated community. This is supported by the fact that 6 of the 10 clinical cases could be linked by the anthropologist in the same genealogy and were, therefore, related. One of the cases in Rarotonga belonged to the same extended genealogy, but had been living away from Pukapuka for 28 years.

The Rarotongans belong to a larger community, with many coming in from outer islands, and are much less closely related. Gout, however, is certainly common in Rarotonga, and a further classical 8 cases were seen in consultation during the period of the survey there, but cannot be included because they were not in the survey sample.

TABLE XII

MEAN SERUM URIC ACIDS IN MG/100ML BY AGE AND SEX

Age Class	MALES			FEMALES		
	Rarotonga	Pukapuka	P.	Rarotonga	Pukapuka	P.
20-29						
No.	83	43		83	54	
Mean	6.84	6.85	N.S.	5.74	6.00	N.S.
S.D.	1.31	0.79		1.18	0.88	
30-39						
No.	45	47		37	47	
Mean	6.75	7.06	N.S.	5.77	6.02	N.S.
S.D.	1.42	1.38		1.20	1.14	
40-49						
No.	40	33		41	28	
Mean	7.35	6.95	N.S.	6.03	6.09	N.S.
S.D.	1.16	0.95		1.21	1.02	
50-59						
No.	40	32		33	31	
Mean	7.38	6.83	N.S.	6.36	6.29	N.S.
S.D.	1.61	1.16		1.04	1.07	
60-69						
No.	18	20		21	21	
Mean	7.05	7.61	N.S.	6.40	6.69	N.S.
S.D.	1.75	1.04		1.21	1.43	
70 & over						
No.	17	13		13	10	
Mean	6.15	7.42	1.0%	6.15	6.73	N.S.
S.D.	0.70	1.63		1.40	1.06	

TABLE XIII

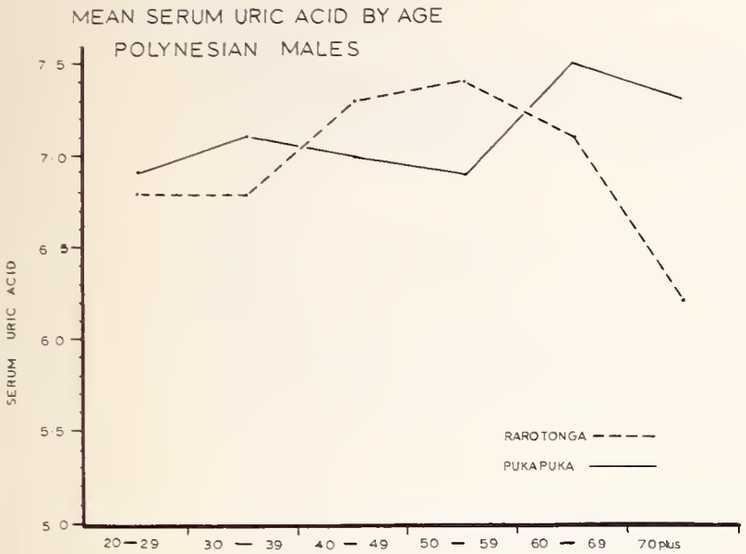
DISTRIBUTION OF SERUM URIC ACIDS

MALES	3	4	5	6	7	8	9	10	11	12	S.U.A. in mg classes
RAROTONGA											
N = 241	.	1	12	52	69	53	38	10	4	2	
%	.	.5	5	21.5	29	22	15.5	4	1.5	1	44% > 7 mg
PUKAPUKA											
N = 188	.	.	6	31	60	61	20	9	1	.	
%	.	.	3	16.5	32	32.5	10.5	5	.5	.	48.5%>7 mg

FEMALES	3	4	5	6	7	8	9	10	11	12	S.U.A. in mg classes
RAROTONGA											
N = 228	1	11	31	88	52	32	10	3	.	.	
%	.5	5	13	38	23	14	5	1.5	.	.	43.5%>6 mg
PUKAPUKA											
N = 191	.	2	26	69	54	30	7	1	2	.	
%	.	1	14	37	27	15.5	4	0.5	1	.	48.0%>6 mg

FIGURE 7

MEAN SERUM URIC ACID LEVELS IN MALES AND FEMALES IN MG/100ML



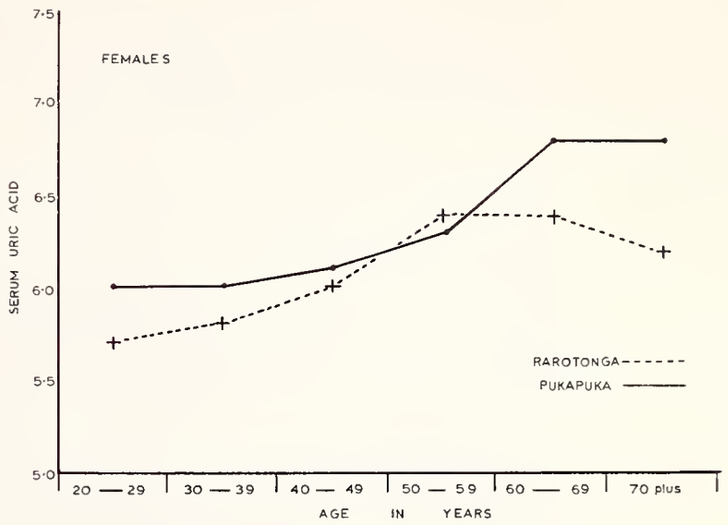
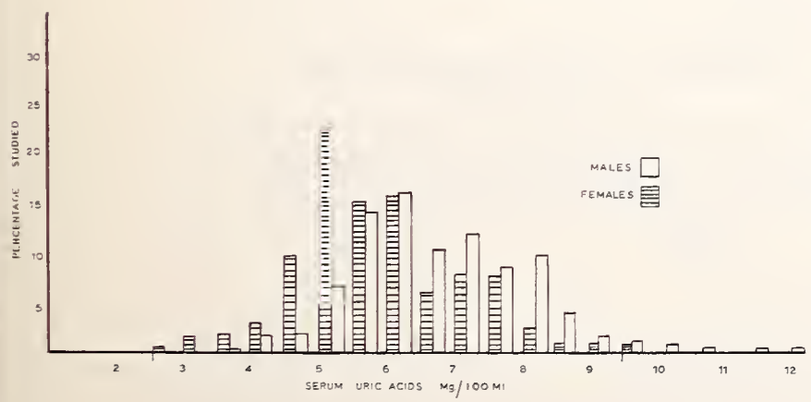


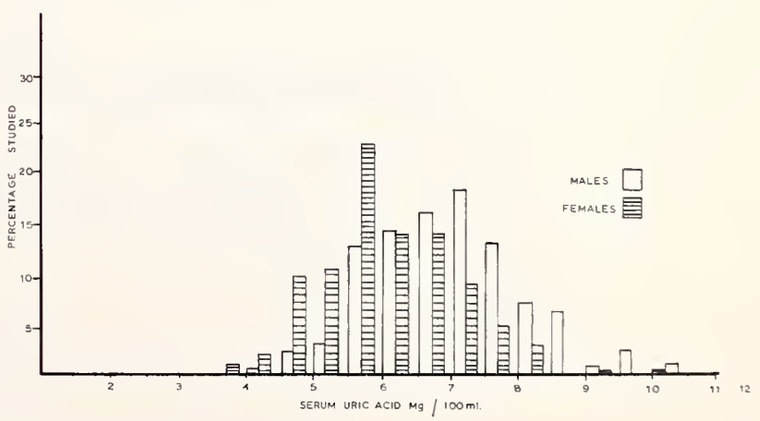
FIGURE 8

FREQUENCY DISTRIBUTION OF SERUM URIC ACID LEVELS
IN MALES AND FEMALES IN 0.5 MG CLASSES

RAROTONGA



PUKAPUKA



Diabetic Abnormality

Using the methods outlined, diabetic abnormality was found in 1 of the males and 4 of the females on Pukapuka, a combined prevalence of 1.3%, and 11 of the males and 9 of the females in Rarotonga, a combined prevalence of 4.2%. Six subjects in Rarotonga and 1 in Pukapuka had been previously diagnosed.

In order to get more information regarding the contribution of weight to development of diabetes, all those aged 60-69 years were given a 100 g. glucose tolerance test, as outlined. The sample sizes were almost the same. The results are shown in Table XIV. The striking finding was that 11, or 52%, of the females had an abnormal glucose tolerance in Rarotonga, and 9 of these had relative weights 120% or more, and can be classed as obese. There were 10 obese in this group. In Pukapuka, there were only 2 females with abnormal glucose tolerance, and neither of these was obese. There were, in fact, only 2 obese women in this group.

The prevalence of diabetic abnormality in the 60-69 year old males was much lower than in the females, 16% in Rarotonga and 10% in Pukapuka. Obesity was present in only 2 males in this age class from each island, and their glucose tolerance tests were normal. The point can be illustrated further by taking the Rarotongan males aged 40-49 years, where there were 40 in the group, and 10 of whom had relative weights 120% and over. Five of the 10 had glycosuria and abnormal glucose tolerance tests, giving a prevalence of 16% in this age class. There were a total of 26 subjects in the total Rarotongan sample shown to have diabetic abnormality, and 18, or 69%, of these had relative weights exceeding 120%, while 8, or 32%, of them were 140% and over, and could be classed as grossly obese.

These results suggest that the Polynesians' predisposition to diabetes is related to the presence of excess weight, and this could explain the lower prevalence among the Pukapukans, compared to that found in Rarotonga.

There were no cases requiring insulin, and only 3 subjects were under 40 years of age.

TABLE XIV

DIABETIC ABNORMALITY IN 60-69 AGE CLASS GIVEN 100 g. G.T.T.

	Sample Number	Diabetic Abnormality	Number of Diabetics Obese	Total Number Obese
	MALES			
RAROTONGA	18	3 (16.6%)	Nil	2
PUKAPUKA	20	2 (10.0%)	Nil	2
	FEMALES			
RAROTONGA	21	11 (52.5%)	9	10
PUKAPUKA	21	2 (9.5%)	Nil	2

Xanthelasma

A striking finding was the complete absence of anyone with xanthelasma palpebrarum on Pukapuka, while there were 5 males and 17 females with this condition in the Rarotongan sample. The association of xanthelasma with lipid disorders and diabetes would suggest that certain differences might be found in the two groups in blood lipid levels.

Blood Lipid Studies:

Cholesterol Levels

The mean serum cholesterols with standard deviations are set out in Table XV for the males and females in the two groups. The distribution of cholesterols is set out in Table XVI. The mean levels are set out in graph form in Figures 9 and 10 for males and females in the two groups.

The cholesterol levels were significantly lower in the Pukapukans as compared to the Rarotongans. Lower overall calorie intake, greater activity and less obesity could be factors contributing to this difference. It is important to note that the levels are lower in the Pukapukans despite 75% of their fat calories coming from the highly saturated coconut source. This is in contrast to the higher levels found by Hunter (1963) in a sample of coconut, fish and taro eaters on Atiu and Mitiaro in the Southern Cook group as compared to a sample on Rarotonga in the land-owning and higher income bracket.

It is also of interest in view of the experimental data which has shown that in individual subjects, substitution of a highly saturated fat such as coconut for predominantly unsaturated fat will result in elevation of the cholesterol level.

The higher levels in Rarotongan females as compared to males in all age classes except the 40-49 year olds may be related to their greater obesity.

Triglyceride Levels

Serum samples after a minimum fast of 8 hours were collected from 74 subjects in Pukapuka and 71 subjects in Rarotonga. There were no significant differences found with age or sex, and the results have been combined for each area. The distribution of triglycerides in mMols/litre is detailed in Table XVII.

The Rarotongan group have 13% with levels above 2.5 mMols, as compared to 1.3% in the Pukapukans.

The mean levels from the two areas were 1.32 mMols, $\pm$ 0.97 mMols in Rarotonga, and .89mMols, $\pm$ 0.47mMols in Pukapuka. This difference is significant at the .1% level.

TABLE XV

BLOOD CHOLESTEROLS BY AGE AND SEX: MEANS AND STANDARD DEVIATION

Age Class	MALES			FEMALES		
	Rarotonga	Pukapuka	P.	Rarotonga	Pukapuka	P.
20-29						
No.	83	43		83	54	
Mean	175.41	159.49	0.01	186.78	175.22	0.05
S.D.	30.57	23.73		29.45	29.36	
30-39						
No.	45	47		37	47	
Mean	193.33	170.83	0.001	201.95	173.70	0.001
S.D.	32.35	30.35		33.90	28.64	
40-49						
No.	40	33		41	28	
Mean	196.50	179.21	0.05	196.49	171.82	0.01
S.D.	36.15	32.22		29.09	30.09	
50-59						
No.	40	32		33	31	
Mean	210.46	185.50	0.01	232.58	200.87	0.01
S.D.	39.45	33.06		49.97	33.56	
60-69						
No.	18	20		21	21	
Mean	199.17	185.55	N.S.	243.05	184.14	0.001
S.D.	35.87	34.71		46.38	42.36	
70 & over						
No.	17	13		13	10	
Mean	202.82	162.23	0.01	207.15	171.10	0.01
S.D.	34.73	30.53		25.15	30.95	

TABLE XVI

DISTRIBUTION OF BLOOD CHOLESTEROLS IN 40 MG. % CLASSES

Age Class	RAROTONGA						PUKAPUKA				
	160	160-199	200-239	240-279	280+		160	160-199	200-239	240-279	280
	MALES										
20-39											
N=128	33	61	28	5	1	N= 90	38	43	8	1	-
%	25.5	47.5	22	4	1	%	42	48	9	1	
40-59											
N= 80	10	28	28	12	2	N= 65	14	35	12	4	
%	12.5	35	35	15	2.5	%	21.5	54	18.5	6	
60 & over											
N= 35	5	12	14	3	1	N= 33	13	11	8	1	
%	14.5	34	40	8.5	3	%	39.5	33.5	24	3	
	FEMALES										
20-39											
N=120	21	47	44	5	3	N=101	39	44	17	1	
%	17.5	39	37	4	2.5	%	39	43.5	16.5	1	
40-59											
N= 74	6	25	24	12	7	N= 59	11	27	17	3	1
%	8	34	32.5	16	9.5	%	19	45.5	29	5	1.5
60 & over											
N= 34	1	7	17	4	5	N= 31	6	16	8		1
%	3	20.5	50	12	14.5	%	19.5	51.5	26		3

FIGURE 9

MEAN SERUM CHOLESTEROLS IN MALES

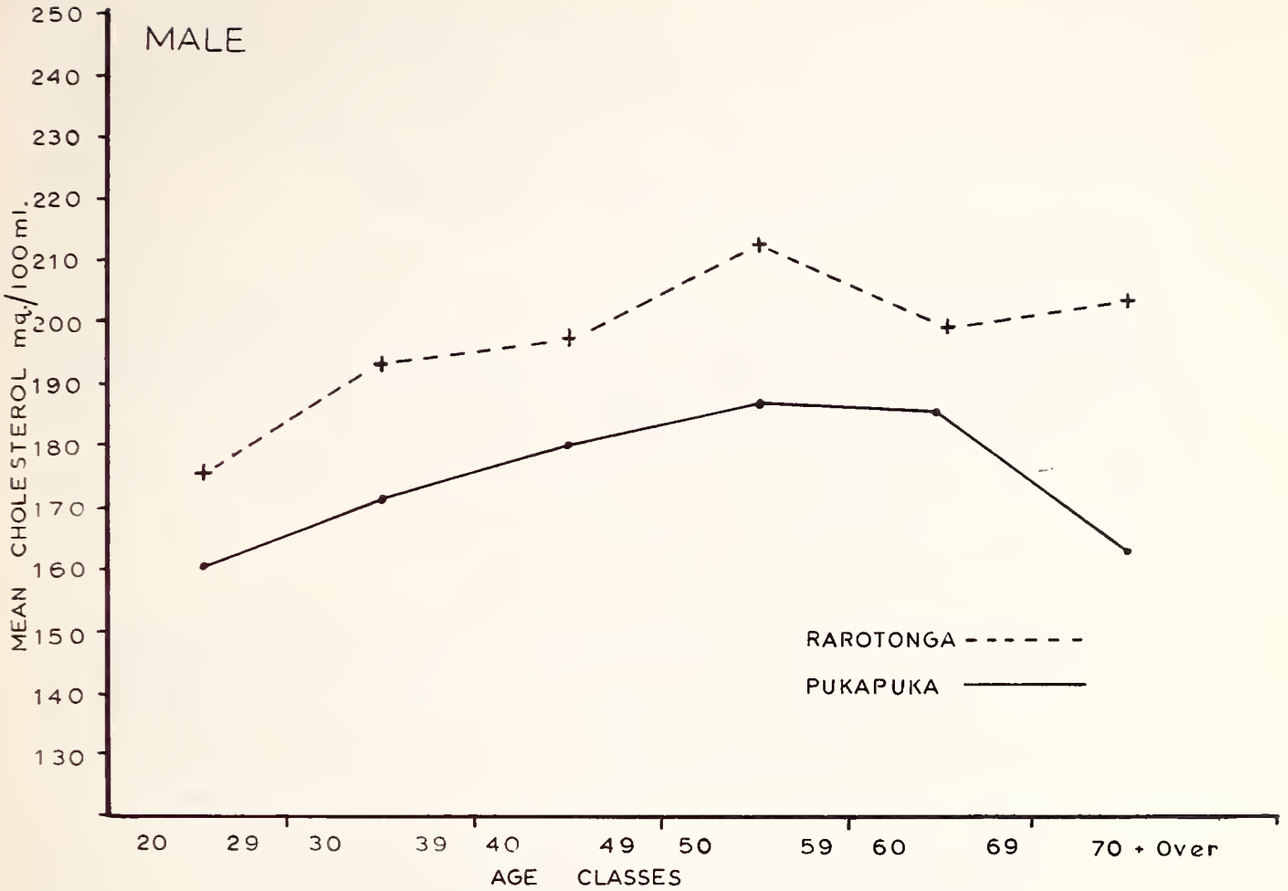


FIGURE 10

MEAN SERUM CHOLESTEROLS IN FEMALES

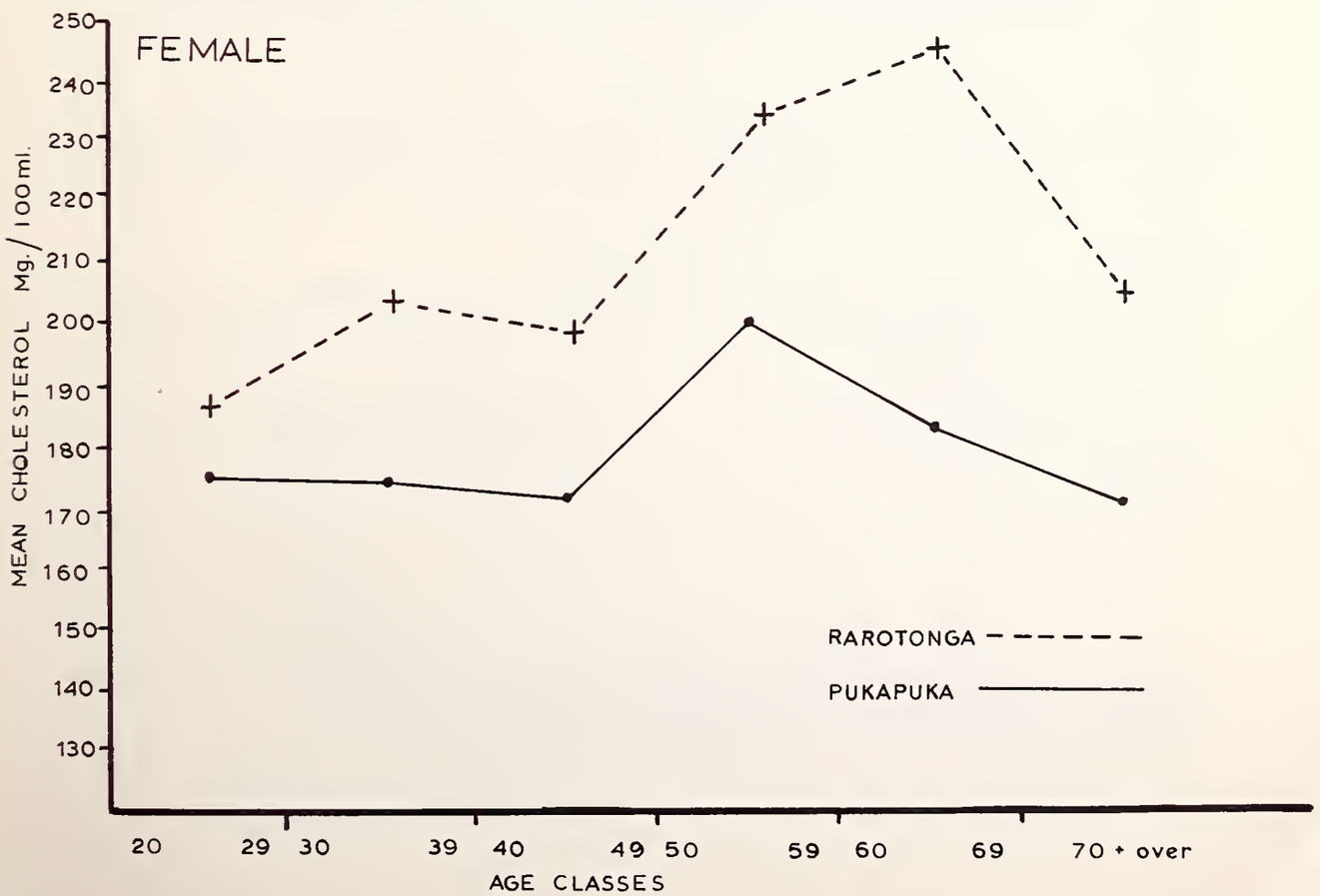


TABLE XVII

SERUM TRIGLYCERIDES IN mMOLS/LITRE *

	NO.	MALES	S.D.	NO.	FEMALES	S.D.
RAROTONGA	35	1.34	1.04	34	1.30	0.93
PUKAPUKA	44	0.93	0.49	29	0.83	0.45

TABLE XVIII

DISTRIBUTION OF FASTING SERUM TRIGLYCERIDES IN mMOLS/LITRE

	mMols/L									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5
RAROTONGA										
N = 71	8	26	13	12	3	2	3	2	1	1
%	11.5	37	18	17	4	3	4	3	1.5	1.5
PUKAPUKA										
N = 74	8	42	15	5	3	1	.	.	.	.
%	11	57	20	7	4	1	.	.	.	.

* To convert mMols/litre to mEq./litre, multiply by three.
To convert mEq./litre to mg/100ml, multiply by 29.4.

Lipomata

The presence of lipomata, either single or multiple, was recorded in the two groups. They were found in 13 males and 3 females in Rarotonga, and in 5 males and 3 females in Pukapuka. A small number of these gave a family history of the condition. The increased prevalence in the Rarotongan males was striking; only 2, however, were obese and 5 of the 13 were over 70 years. No other associations were noted, and it is considered that their occurrence is best explained on a genetic basis.

Filariasis

Filariasis is endemic throughout the Cook Islands, and earlier work by McCarthy (1959) had shown that Pukapuka had one of the highest rates of affected people, around 56%. It was decided to examine for microfilaria using Knott's method, where a venous sample is taken, rather than relying on a finger-prick smear. The sample of 1 ml. was lysed, centrifuged, and the deposit stained with Giemsa stain. The prevalence of microfilaria using this method was more than 80% and reach 95-100% in some age groups. This is very much higher than has previously been reported. See Table XIX. Comparable data on the whole of the Rarotongan sample is not available, but a pilot survey using the same method showed a very much lower prevalence of infected people, around 30%.

History of Filaria and Clinical Findings

A history of recurrent fever consistent with filaria, in many cases associated with lymphangitis, was obtained in 53 males and 21 females in Rarotonga and 65 males and 34 females in Pukapuka. Evidence of elephantiasis involving the scrotum in males, or one or more limbs, was found in 6 males and 3 females in Rarotonga and 9 males and 6 females in Pukapuka.

The presence of a hydrocoele, or a history of one having been operated on, was taken as an index of filarial infection, and was common in both groups. Eighteen males in Rarotonga, 13 of whom had been treated surgically, gave a history of hydrocoele, as compared to 19 on Pukapuka, only 2 of whom had been operated on. The spectrum of symptoms and disability related to lifelong filariasis has yet to be clearly defined, and certain of the other clinical differences observed between the Rarotongans and Pukapukans could be related to the extremely high rate of endemic filariasis that was demonstrated. Skeletal changes causing chest and back pain have been briefly referred to, while the finding in the Pukapukans of a much higher number with a form of choroiditis causing areas of scattered white exudate may be related to their higher filaria involvement.

TABLE XIX

PREVALENCE OF POSITIVE MICROFILARIA SMEARS BY AGE AND SEX ON PUKAPUKA

Age Class	MALES			FEMALES		
	Sample	Number Positive	% Affected	Sample	Number Positive	% Affected
20-29	31	27	87%	43	39	90%
30-39	37	32	86%	35	29	83%
40-49	26	22	85%	21	18	86%
50-59	26	24	92%	26	25	96%
60-69	17	14	82%	18	15	83%
70 & over	10	8	80%	10	10	100%

Skeletal and Joint Symptoms:

Complaints of recurrent pain and stiffness in joints and limbs were common in both groups, and have been classed as arthralgia where no swelling, limitation of movement or bony overgrowth was found. Cases were classed as osteoarthritis when limitation of movement and/or bony swelling was present. This includes some cases with considerable limitation of movement of cervical and lumbar spine, in whom bony overgrowth was not demonstrated.

Arthralgia

There were 65 males and 66 females on Rarotonga and 78 males and 84 females on Pukapuka who came into this category. These symptoms were related to previous trauma to joints in about one-third of the males.

In 8 males and 1 female on Pukapuka, the joint symptoms had occurred at the time of episodes of filaria fever, and knees were the joints most commonly involved. This history was obtained in 3 males on Rarotonga, one of whom was seen during an acute attack with an effusion in his knee-joint.

Evidence of osteoarthritis was found in 15 males and 12 females on Rarotonga, and in 21 males and 12 females on Pukapuka. Hands, knees and shoulders were the commonest joints affected.

Chest and Back Pain

A history of low back pain was much more common on Pukapuka than on Rarotonga, and this finding, combined with the remarkable prevalence of skeletal chest and upper back pain among them, demands an explanation.

Local spinal tenderness was also noted more frequently among the Pukapukans, even in the absence of specific symptoms.

A number of subjects had symptoms related to both the upper and lower back.

The data relating to spinal and skeletal chest symptoms and signs are detailed in Table XX. The cause, or causes, of the remarkable difference between the two groups is not clear; it is unlikely that it is related simply to differences in repetitive back trauma associated with work. Both groups of men were undertaking heavy manual work at times, although copra-cutting and prolonged paddling was more common among the Pukapukans. The important features of the skeletal chest pain have been described in the section on chest pain. It is considered, without any clear evidence to support the hypothesis, that in some way, chronic endemic filariasis could be contributing to the findings by setting up some reaction around intervertebral joints which in turn irritates dorsal and ventral nerve roots and causes pain.

TABLE XX

PREVALENCE OF SPINAL AND SKELETAL CHEST SYMPTOMS AND SIGNS

SYMPTOM	RAROTONGA		PUKAPUKA	
Sample	Males 243	Females 228	Males 188	Females 191
Skeletal chest pain with spinal tenderness	14	11	52	54
Skeletal chest pain without spinal tenderness	11	15	31	36
Spinal tenderness without a history of chest or back pain	8	10	20	30
Low back pain	20	15	80	61

Ophthalmological Data:

Choroiditis

The most striking and unexpected finding was the prevalence of choroiditis in both groups, with a notably higher proportion affected in Pukapuka. The condition is usually bilateral and consists of scattered white or grey areas of exudate of varying size throughout the fundus. In some subjects, larger areas occurred with surrounding pigmentation. One case was found in a male in his twenties, one in his thirties, but the remainder were in subjects over forty. Visual impairment was not common from the lesion, but occurred in some cases where the exudate was close to the macula. Retinal photographs were taken in the majority of subjects aged 40 and over on Pukapuka, and so objective records of the lesions are available.

Pterygium

Pterygium of varying degree was extremely common in both groups, but more in Pukapuka than in Rarotonga. A detailed account of the prevalence of this condition was not kept.

Cataracts and corneal opacities were also common and were causing real disability in some cases.

The prevalence of the different ophthalmological conditions is detailed in Table XXI.

The choroiditis is felt to be related to filariasis at least in the majority of cases and the higher prevalence on Pukapuka would be consistent with this. In the older subjects some of the changes could be due to a type of senile choroidal degeneration. Similar changes, however, were described and attributed to filariasis by Leber in 1914 and, in more detail, in 1954 by Crawford in a report from the South Pacific Commission.

TABLE XXI

OPHTHALMOLOGICAL DATA

SYMPTOM	RAROTONGA		PUKAPUKA	
Sample	Males 243	Females 228	Males 188	Females 191
Choroidal exudate	4	3	11	10
Cataracts	6	11	7	5
Corneal opacities	4	6	2	1
Grade 2 hypertensive changes	14	25	.	.

Chest Conditions:

Pulmonary Tuberculosis

The finding of 8 male and 5 female cases of previously undiagnosed pulmonary tuberculosis in the total Rarotongan sample of 471 adults gives an indication of the extent of this problem in the Cook Island Maoris.

In Pukapuka the problem was also an important one, as 6 new male and 3 new female cases were discovered in the sample of 379 adults.

Nine of those on Rarotonga, and 4 on Pukapuka, were regarded as active cases requiring treatment; the remainder did not show evidence of cavitation or extensive infiltration and were to be observed.

In addition to the cases not previously recognised, there were 13 males and 7 females with abnormal X-rays in the Rarotongan sample who had been under treatment in the past, and 4 males and 2 females who were on home treatment with anti-tuberculous therapy at the time of the Survey.

In Pukapuka there were 5 males and 2 females who had been previously diagnosed and treated. There were, in addition, a number on both islands who had areas of calcification on their radiographs that were certainly evidence of old tuberculous infection, but there was no pulmonary infiltration or evidence of activity. and they have not been included in the assessment.

The data presented give a clinical attack rate for pulmonary tuberculosis of 10% in males and 6% in females in the Rarotongan sample, and 6% in males and 2.5% in females in Pukapuka. One case of tuberculous meningitis developed a week after the survey team left Pukapuka. This occurred in the wife of a man of 37 who had been discovered during the survey to have extensive bilateral pulmonary disease and commenced on treatment.

There were, in addition, a number who gave a history of having had periods of treatment for tuberculosis in the past; their X-rays were normal and they have not been included in the estimate of the prevalence rate.

It is quite clear that pulmonary tuberculosis is a major problem that will require a continuing case finding and treatment campaign. It is customary in Rarotonga to X-ray all pregnant women, and this could explain why no new cases were found in females under 50 and yet there were 7 new cases in males under 50. A systematic and properly planned mass X-ray campaign would undoubtedly produce a large number of previously undiscovered cases and would be a major step in producing more effective control of this important disease.

Non-Tuberculous Chest Conditions

Intercurrent upper and lower respiratory infections are uncommon on Pukapuka, but occur with normal frequency in Rarotonga.

The way in which an acute viral respiratory infection can spread through an isolated community was shown very clearly on Pukapuka. Introduced by passengers on the boat, it quickly spread through the community and it is estimated that around 85% of the entire community were affected to a varying extent. Coryza, fever, cough and sputum were the principal symptoms and the usual duration of symptoms was 7-10 days. The severity varied considerably, and a number developed frank clinical evidence of pneumonia. The condition is called by the Pukapukans "the sickness and cough of the boat" and is a well-recognised phenomenon. Evidence that it was commonly accompanied by areas of pulmonary infiltration was shown by the fact that 14 males and 18 females had opacities in their chest radiographs, which were subsequently shown to have cleared in those in whom further films were taken. The majority of radiological changes were in the lower or middle lobes.

Chronic Bronchitis

Participants were placed in three classes: those with cough and sputum lasting 3 months or more each year; those with cough and sputum each day; and those with daily cough and sputum and breathlessness. The difference between the two groups was quite striking, with symptoms of chronic bronchitis occurring much more frequently among the Rarotongans.

More frequent intercurrent respiratory infections and heavier smoking among the Rarotongans could be factors contributing to these differences. The data relating to chronic bronchitis are shown in Table XXII.

There were 2 males in Rarotonga who are included in the above table who had definite clinical and radiological evidence of chronic bronchiectasis.

Other Abnormalities

Sequestrated Segment

One symptomless female aged 42 on Pukapuka had a lesion in the right lower lobe consistent with a sequestrated segment.

TABLE XXII

PREVALENCE OF CHRONIC BRONCHITIS

	Sample Number	Intermittent Cough and sputum for at least 3/12 of Year	Daily Cough and Sputum	Daily Cough, Sputum and breathlessness
		MALES		
RAROTONGA	243	3	9	5
PUKAPUKA	188	4	4	1
		FEMALES		
RAROTONGA	228	5	4	6
PUKAPUKA	191	.	2	.

Genetic Abnormalities:

A variety of genetic abnormalities were found in both Island groups, including a family with congenital deafness associated with short toes, a family with multiple lipomatosis, an albino family with varying degrees of depigmentation and nystagmus.

It was noted that the gene, or genes, causing auburn hair was much more common in Rarotonga than in Pukapuka.

The prevalence of xanthelasma in the Rarotongan sample has been referred to and a family history was obtained in a number of these cases.

The contribution of genetic factors to the differences observed between the two groups is to be carried further by estimating the gene frequencies for haptoglobins and transferrins.

The findings relating to hyperuricaemia and gout indicate that the genes contributing to this condition are certainly present in both communities. The notably higher gout rate among the New Zealand Maori males, namely 38 out of a total sample of 370 aged 20 and over, suggests that environmental factors could be aggravating and enhancing the way in which the condition declares itself. A higher fat and alcohol intake are thought to be particularly important. (Prior, Rose, Harvey and Davidson. 1966)

Diet:

Information of food habits and meal patterns was obtained by the 24-hour recall method from subjects at the survey centre throughout the whole period of the survey in Pukapuka, but for the first three weeks only in Rarotonga. In Pukapuka, because of the very limited variety of foods used, and the ability of the Pukapukans to demonstrate accurately the size of the portions eaten, the 24-hour recall data were used to assess quantitatively the mean daily food intake of subjects aged 40 to 69. Results are similar to those obtained in the seven-day survey made of 13 village households. See Table XXIII.

A modified household survey was made on both islands to obtain information on food intake of individuals. Because of limitations imposed by time, only those in the 40-69 age group could be included in this survey. Food used by the household was weighed, measured or counted, and details of the amounts eaten by the subject being studied were recorded. A record was kept of foods eaten away from home. The simplicity of meals, the custom of equal shares, and the easily measurable portions used, made it possible to obtain reasonably accurate estimations of food intake of individuals in different age groups in both islands by this method. The period of time was two days in Rarotonga, where it was found after a trial period that there was remarkably little variation from day to day in the average diet. In Pukapuka, where food intake of the individual often varied greatly from day to day, records were kept for seven days. On both islands all those participating in the dietary surveys were subjects of the major surveys.

The Rarotongan diet study included 50 men and 57 women, aged 40-49, from 52 households with weight and age status similar to that of the whole sample. Any who were ill, or were fasting or feasting or drinking excessively at the time of the study were omitted, thus making it probable that consumption of some items, beer for example, has been underestimated for the group as a whole. In Pukapuka, the study included 13 women and 17 men in 13 village households. They were not necessarily representative of the whole island group, but were chosen for reasons of accessibility.

Meal Patterns and Foods Used

Rarotonga: The main meal was taken at midday, and consisted most frequently of canned meat or fish, taro or rice, or cooked bananas, vegetables such as taro tops, cabbage, onions or tomatoes, and coconut sauce as a relish. The latter is made from the cream extracted from grated meat of mature coconut diluted with water. Traditionally, sea-water was added, but now tap-water and salt are used. The richer un-diluted cream was used by a few families in coffee or tea. The breakfast and evening meals were usually bread, occasionally with canned meat or fish. Tea was the most usual beverage, sugar being added to the tea in the pot. The frequency of use of butter, fresh meat and fish varied and was decided by economic factors.

There was remarkably little variation from day to day in individual diets and, in the older age groups, often little difference between the food intake of husbands and wives. Where the wife was working and the husband at home, the wife's food intake tended to exceed the husband's because of additional snacks taken at work.

Pukapuka: No meal pattern was discernible, the most noticeable feature being the very great variation in individual food consumption from day to day.

Fish, taro and coconuts are the staple foods in the Pukapukan diet, but during the period of the survey, flour, rice, sugar, tea and canned corned beef were commonly used. The consumption of these foods was almost certainly higher than it would have been for a longer period which included times when supplies of imported foods were low or non-existent, but no records could be obtained of quantities of food imported into the island in recent years, so no estimation of yearly per capita consumption could be made.

Coconuts were used green, as drinking nuts; mature, as cream for use in taro, rice and flour dishes, and sprouted. Many kinds of fish were used; they were eaten raw, grilled or cooked in the earth oven. Pancakes made of flour and water and cooked in dripping were frequently used as the main item in the meal. Some bread was baked, but was not a common article of diet. Sugar was used chiefly in tea. The use of milk, eggs, butter, fruit and vegetables was negligible. Small amounts of pork and poultry were eaten, most commonly on Sunday or at feasts. Unlike the Rarotongans, who used coconut sauce as a relish four to six times a week, the Pukapukans ate coconut sauce infrequently. Virtually no salt was added to the food, and the majority of households questioned said they had no salt in the kitchen or food store.

Foods Providing Calories

Main sources of calories in Rarotongan and Pukapukan diets are shown in Table XXIV. Cereals, taro and other roots, canned meat and fish were the chief sources of calories in Rarotongan diets; in Pukapuka, coconut provided more calories than any other single food, followed by taro and cereals. The amounts of protein, fat and carbohydrate, and number of calories provided by these foods, are given in Table XXIII. The major difference in the two diets was the higher carbohydrate and, consequently, higher calorie intake of the Rarotongans. There was little difference in the protein content of the two diets; fat content was similar in quantity, but different in quality. Seventy-five per cent of fat in the Pukapukan diet was from the highly-saturated coconut fat, as compared to less than twenty-five per cent from this source in Rarotongan diets. In Rarotonga, meat and butter fats provided the bulk of fat calories. The contribution from fish oils was not high in either group, but greater in Pukapuka than in Rarotonga. The mean per caput fish consumption of the Rarotongan group was roughly half an ounce of canned, and an ounce and a half of fresh fish daily, the latter being largely gutted, frozen, imported fish. In Pukapuka, consumption was approximately six ounces daily of fresh fish, mainly in the form of small fish, of which all except bones were eaten. Fish oils from the small, whole fish eaten, probably provided constant intake of polyunsaturated fatty acids, but amounts would be very low in relation to total fatty acid content of the diet.

Calorie Intake

In the males, the calorie intake of Pukapukans was 83% of the intake of Rarotongans; in the females, the Pukapukan's intake was 86% of the Rarotongans. Obesity was more prevalent in Rarotongan than in Pukapukan males, but the difference was not great; 13% of Rarotongan males in the 40-69 age group were obese as compared with 8% of Pukapukan males in the same age group. The difference is largely due to the number of obese Rarotongan males in the 40-49 years group; Pukapukan males in their fifties were in fact fatter than Rarotongan males. The Pukapukan males were shorter and appeared to retire from strenuous activities at an earlier age than Rarotongans and in middle and old age, their calorie requirement may well be lower.

There was a marked difference in the prevalence of obesity in the two groups of females; 54% of the Rarotongan females were obese (including 32% grossly obese) compared with 21% of Pukapukan females (including 3% grossly obese). It seems likely that the difference in prevalence of obesity in the two groups is due not so much to the fairly small difference in energy intake as to difference in energy output. Although no studies of activity could be made, on observation it appeared that the Pukapukan women remained active even in extreme old age whereas many Rarotongan women were often markedly inactive. These women were not idle but many of their tasks and pastimes required little movement, in

contrast to those of the Pukapukan women, whose duties in the household and the taro swamps resulted in continuous although not strenuous activity.

The difference between calorie intake of males and of females in both groups is considerably less than that suggested in recommended calorie allowances for temperate zones. The mean daily calorie intake of Rarotongan men exceeded that of women by 200 calories; the Pukapukan man's intake was only 60 calories (recall method) to 105 calories (weighed survey) in excess of that of the Pukapukan woman.

In both groups obesity was much more prevalent in females than in males as would be expected when food is shared almost equally among the sexes.

There is evidence that in Rarotonga this is by no means a recent development. Forty years ago Lambert (1925) noted that the Cook Island man worked hard and that in addition to his outside labours, he usually had to do a lot of the cooking and other housework. Lambert commented "The natural consequence is a rather fat lot of women, who, speaking relatively, have about the easiest time of any womankind I know."

TABLE XXIII

ANALYSIS OF DAILY FOOD INTAKE
MALES AND FEMALES, AGED 40-69

INTAKE	MALES			FEMALES		
	RAROTONGA	PUKAPUKA 24-hour Recall	PUKAPUKA 7-day Intake	RAROTONGA	PUKAPUKA 24-hour Recall	PUKAPUKA 7-day Intake
No. in sample	50	76	17	57	77	13
Protein g.	63	62	61	58	52	58
Fat g.	66	66	70	61	72	69
Carbohydrate g.	330	255	236	300	237	215
Calories	2,190	1,862	1,818	1,985	1,804	1,713
Calories from:						
Protein	12%	13%	13%	12%	12%	14%
Fat	27%	32%	35%	28%	36%	36%
Carbohydrate	60%	55%	53%	60%	52%	50%
Alcohol	1%	.	.	neg.	.	.
Fat calories from:						
Coconut	22%	74%	79%	23%	76%	79%

TABLE XXIV

CALORIC CONTRIBUTION FROM DIFFERENT FOODS IN TWO GROUPS

RAROTONGA		PUKAPUKA	
Food	% of Total Calories	Food	% of Total Calories
Cereals	36	Coconut	36
Taro and other roots	17	Cereals	25
Meat and fish, canned	10	Taro	20
Meat and fish, fresh	7	Meat and fish, fresh	11
Coconut	7	Meat and fish, canned	2
Sugar	7	Dripping	3
Butter and dripping	7	Sugar	2
Fruit and vegetables	4		
Milk, eggs, ice cream	2		

PARITY DATA

The information regarding the number of full-term or near full-term pregnancies in the Rarotonga and Pukapuka women is detailed in Table XXV. The number in the different age groups who had never been pregnant is also shown. The striking finding is the evidence of relative infertility in the Pukapuka women in the 40-49 and 50-59 year groups where 21.4% and 35.4% respectively had never been pregnant as compared to 14.6% among the Rarotonga women of the same age groups.

A variety of explanations can be put forward; the effect of widespread gonococcal infection on the island 25-30 years ago is the most likely explanation.

The mean number of pregnancies in those aged 40 and over was 4.9 in Pukapuka, 6.2 in Rarotonga as compared to 7.0 in the combined New Zealand Maori sample and 2.8 in the survey of European subjects in Carterton.

TABLE XXV

PARITY DATA

RAROTONGA

Age Group	Number	Number of pregnancies	Mean	Number never pregnant	% never pregnant
20 - 29	83	220	2.65	11	13.2
30 - 39	37	218	5.89	4	10.8
40 - 49	41	275	6.70	6	14.6
50 - 59	32	171	5.34	4	12.5
60 - 69	21	144	6.85	2	9.5
70 and over	13	80	6.15	2	15.38
40 and over	107	670	6.26	14	13.08

PUKAPUKA

Age Group	Number	Number of pregnancies	Mean	Number never pregnant	% never pregnant
20 - 29	54	136	2.51	8	14.8
30 - 39	47	243	5.17	5	10.6
40 - 49	28	148	5.28	6	21.4
50 - 59	31	109	3.51	11	35.4
60 - 69	21	135	6.42	2	9.5
40 and over	90	449	4.98	22	24.4
70 and over	10	57	5.7	3	30.0
40 and over	90	449	4.98	22	24.4

SMOKING HABITS

Subjects were classified into the following categories: Non-smokers - subdivided into those who had never smoked, and those who had given up smoking. Smokers - subdivided into those smoking tailor-made cigarettes, or their equivalent in tobacco (a) less than 10 daily, (b) 10 - 19 daily, (c) more than 20 daily. Details set out in Table XXVI.

TABLE XXVI

SMOKING HABITS

	RAROTONGA				PUKAPUKA			
	Males		Females		Males		Females	
	N	%	N	%	N	%	N	%
Never smoked	57	23.5	155	67.9	42	22.3	107	56.0
Given up smoking	21	8.6	3	1.3	7	3.7	8	4.2
Total non-smokers	78	32.1	158	69.2	49	26.0	115	60.2
Less than 10 daily	26	10.7	44	19.2	35	18.6	64	33.5
10 - 19 daily	93	38.4	22	9.6	83	44.1	9	4.7
20 or more daily	45	18.5	4	1.7	21	11.1	3	1.6
	N = 242		N = 228		N = 188		N = 191	

COMPARISON OF NEW ZEALAND AND COOK ISLAND MAORI DATA

The surveys on the first group of New Zealand Maoris studied have been reported (Prior, 1962; Prior, Rose and Davidson, 1964) and, since that time, two further groups have been surveyed, giving comparable data on a total of 370 males and 385 females aged 20 and over (to be published).

The variety of cardiovascular and metabolic abnormalities found have been referred to, and were the stimulus which led to studying Polynesians living outside of New Zealand.

A comparison of the important findings in these fields is detailed in Table XXVII in the subjects aged 30 and over. The New Zealand Maori males have a greater extent of obesity and gross obesity, gout and diabetic abnormality, as compared to the other two groups. The New Zealand Maori females show a similar extent of obesity and gross obesity to the Rarotongans, but have a higher prevalence of ischaemic heart disease. The Rarotongan females' predisposition to hypertension is clearly shown. The Pukapukans, both male and female, can be seen to have a much lower prevalence in all conditions detailed in the Table XXVII.

TABLE XXVII

COMPARISON: NEW ZEALAND AND COOK ISLAND MAORI DATA IN SUBJECTS AGED 30 AND OVER

MALES	No. in Sample	B.P.160/95 and over	Ischaemic Heart Disease	Gout	Diabetes	Obese 120-139 % R.Wt.	Grossly Obese 140% R.Wt.
N.Z. Maori	285	48	14	38	34	53	26
%		16.9%	4.9%	13.3%	11.9%	18.6%	9.1%
Rarotonga	160	34	7	6	10	13	6
%		21.0%	4.3%	3.7%	6.2%	8.0%	3.7%
Pukapuka	145	3	3	10	3	10	1
%		2.0%	2.0%	7.0%	2.0%	7.0%	0.7%
FEMALES							
N.Z. Maori	280	70	24	7	26	61	60
%		25.0%	8.5%	2.5%	9.3%	21.8%	21.4%
Rarotonga	145	53	8	.	14	32	36
%		36.0%	5.5%	.	9.5%	22.0%	25.0%
Pukapuka	137	6	2	.	6	29	3
%		4.4%	1.4%	.	4.4%	21.0%	2.2%

GENERAL CONCLUSIONS

The surveys of these two groups of Cook Island Maoris living at different stages of material development and exposure to European influence have revealed a variety of important differences between the groups.

The sample in Rarotonga, chosen because they had lived under town conditions there for 10 years or more, have a very different health pattern when compared to the isolated low coral atoll dwellers on Pukapuka.

The virtual absence of hypertension among the Pukapukans, with no increase in blood pressure with age, can certainly not just be attributed to the difference in weight pattern and obesity between the groups. The difference in salt appetite, intake and output was carefully documented and is considered to be a factor of importance. The possibility that the handful of Pukapukans surviving the tidal wave of 300 years ago did not have the genes contributing to hypertension must be admitted, but other groups in the Pacific have been described in whom hypertension is absent, and a dietary or environmental link is the likely one between these groups.

Differences in socio-cultural stresses are undoubtedly present, and could be contributing factors. These are difficult to define, but the slower pulse rate of the Pukapukans could be an indication of less ortho-sympathetic activity among them. Their communal way of life, the sharing of responsibility, and the emphasis in the community on sport, singing, church activities and relaxation were other differences noted. Differences in manifest vascular disease have been found, with less ischaemic heart disease and other evidence of atherosclerosis among the isolated Pukapukans. The difference in the prevalence of aortic systolic ejection murmurs could also be related to the pattern of atherosclerosis and hypertension in the two groups.

The genetic factors contributing to diabetes are present in both groups, and the effect which obesity has in making the condition manifest is clearly shown in certain of the Rarotongan groups.

The Polynesian predisposition to hyperuricaemia and gout has now been shown in groups living under very different environmental conditions. The distribution of the serum uric acid is similar in the two Cook Island groups and the New Zealand Maoris (Prior et al 1966), and the absence of any bimodality of the curves would argue against the hyperuricaemia being due to a single gene abnormality.

The differences in prevalence of gout between the groups could have been due to chance, although the fact that the percentage of calories from fat was higher in the Pukapukans with 75% of fat calories being derived from the highly-saturated coconut needs to be considered and studied further.

The considerable extent of obesity among the Rarotongan females is a major problem, and is considered to be one of the factors contributing to the hypertension found, certainly in the grossly obese.

The Rarotongan dietary data, showing that in households studied the females do, in fact, eat almost as much as the males, is clearly contributing to their obesity. As a group, they are also much less active than the Rarotongan males and the Pukapukans. The overall calorie intake of the Pukapukans is lower than the Rarotongans, and their subsistence living places more continuing demands for physical activity on both males and females, which clearly lessens the chance of their becoming overweight.

The higher prevalence of endemic filariasis in the Pukapukans raises a number of questions relating to other differences observed between the two groups.

The occurrence of choroiditis has been considered by previous workers to result from filariasis, and these surveys would appear to support this.

The remarkable extent of skeletal symptoms, particularly relating to the cervical, dorsal and lumbar spine, is put forward as also being related to the high rate of filaria infection. A mass filaria treatment programme on Pukapuka

was introduced following the survey and is to be carried on over a period of a year. A review after a period of several years, when the filaria rate had been successfully lowered, would produce valuable information about the ways in which this disease can manifest itself.

The comparison made in Table XXV with data available from surveys carried out in a comparable way among samples of New Zealand Maoris, indicates clearly the pattern of disease that is emerging among Polynesians as they are exposed to European influence, ready availability of food, and a so-called Western way of life. The long-term effect which such trends are having on the health of the race is supported in New Zealand by mortality statistics indicating a high mortality experience from these conditions, particularly in the Maori females.

The public health implications of these findings, and the challenge they pose to the people of the Pacific, is a very considerable one. It is particularly vital to New Zealand, where the Maori and European sections of the community are gradually merging, and where the Maori and part-Maori people are increasing at one of the highest population growth rates in the world. At the same time, the migration of Polynesians from the Islands of the Pacific to New Zealand is increasing. The health and disease pattern of the Polynesian section of the New Zealand community, and of the South Pacific countries, will need to be favourably influenced if they are to contribute as they should to the economic and general development of New Zealand and the South Pacific.

SUMMARY

- The results of general health surveys of two groups of Cook Island Maoris living under contrasting environmental and material conditions are presented.

- The samples comprised a group of 471 adults who had lived under town conditions in Avarua, Rarotonga, for 10 years or more, and 379 adults who were leading a subsistence and traditional living on the isolated coral atoll of Pukapuka.

- A variety of important differences relating to anthropometric, cardio-vascular and metabolic factors have been defined. Obesity is common in the Rarotongan females, but not in the males. Blood pressure increases with age in both sexes in Rarotonga, but not in Pukapuka, where significant hypertension was virtually absent. The Pukapukans have a much lower salt intake as compared to the Rarotongans, and this is considered to be an important factor related to the absence of hyper-tension. Vascular disease, manifest by ischaemic cardiac pain, or evidence of cerebo-vascular disease, was less common in the Pukapukans. The cholesterol and triglyceride levels were higher in the Rarotongans, as compared to the Pukapukans, despite the latter group getting 75% of their fat calories from the highly saturated flesh of coconuts. The total calorie carbohydrate and sugar content of the diet was found to be lower in the Pukapukans.

- A remarkably high prevalence of skeletal chest and back pains was recorded in both groups; this was higher in the Pukapukans, and the hypothesis that it may be related to filariasis is put forward.

- Tuberculosis was a major problem in both groups and makes it clear that a large-scale X-ray screening programme should be undertaken. Chronic bronchitis was more common in the Rarotongans, who were heavier smokers.

- Hyperuricaemia was found in both groups in males and females, and the prevalence of gout in the males was 5.3% in Pukapuka and 2.5% in Rarotonga.

- Diabetic abnormality was found in 4.2% of the Rarotongans and 1.3% of the Pukapukans.

- The contribution of excess weight to the development of diabetic abnormality was shown in a special study of the 60-69 year olds in the two islands.

- A comparison is made with the findings in surveys of the New Zealand Maoris, and the pattern of development of cardiovascular and metabolic abnormalities with increasing exposure to western influence and environment is shown.

ACKNOWLEDGMENTS

The work was supported by the Medical Research Council of New Zealand, together with a grant from the World Health Organization.

The authors wish to acknowledge the help they received from the survey team and from the many people, both in New Zealand and the Cook Islands, whose assistance made the surveys possible.

The work of the staff of the Wellington Hospital Medical Unit Laboratory, who have carried out the biochemical estimations, is also gratefully acknowledged.

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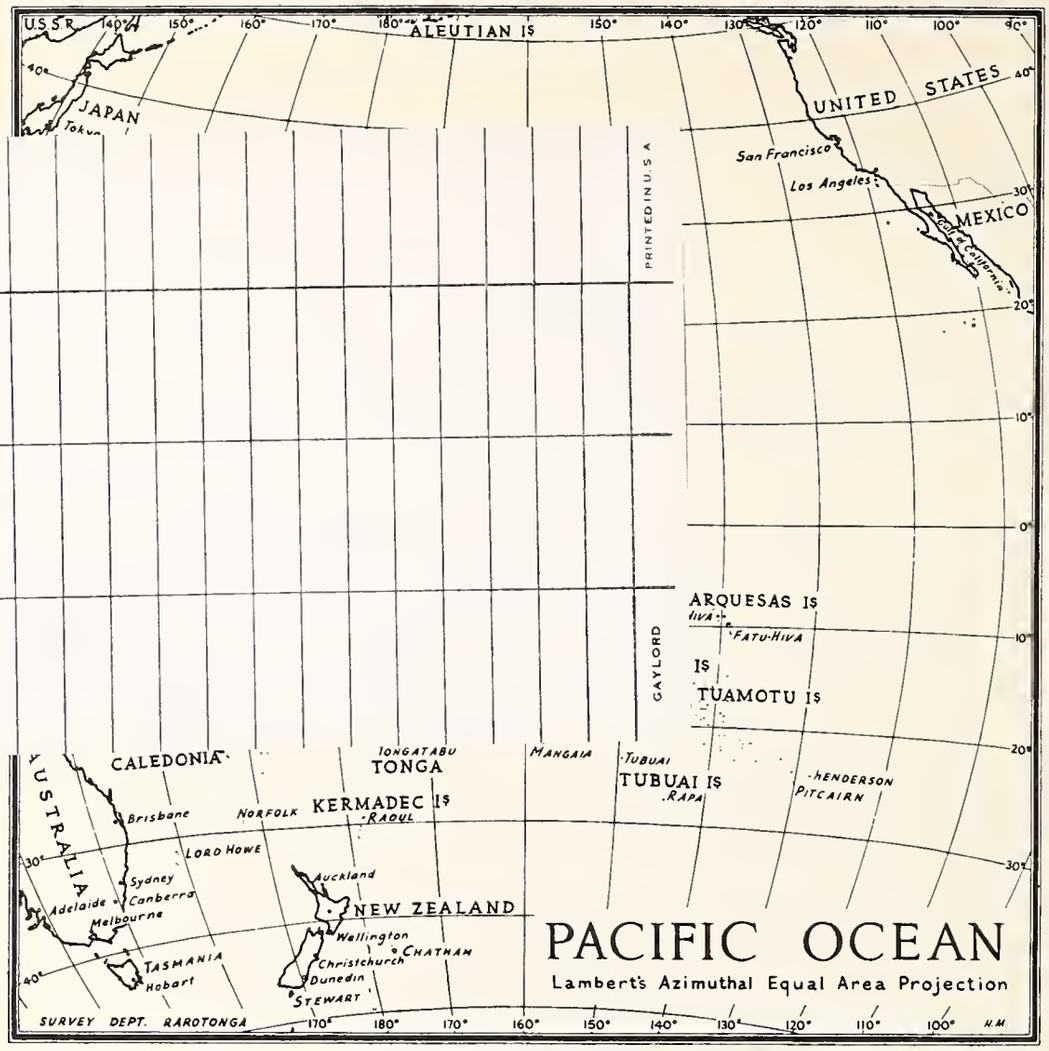
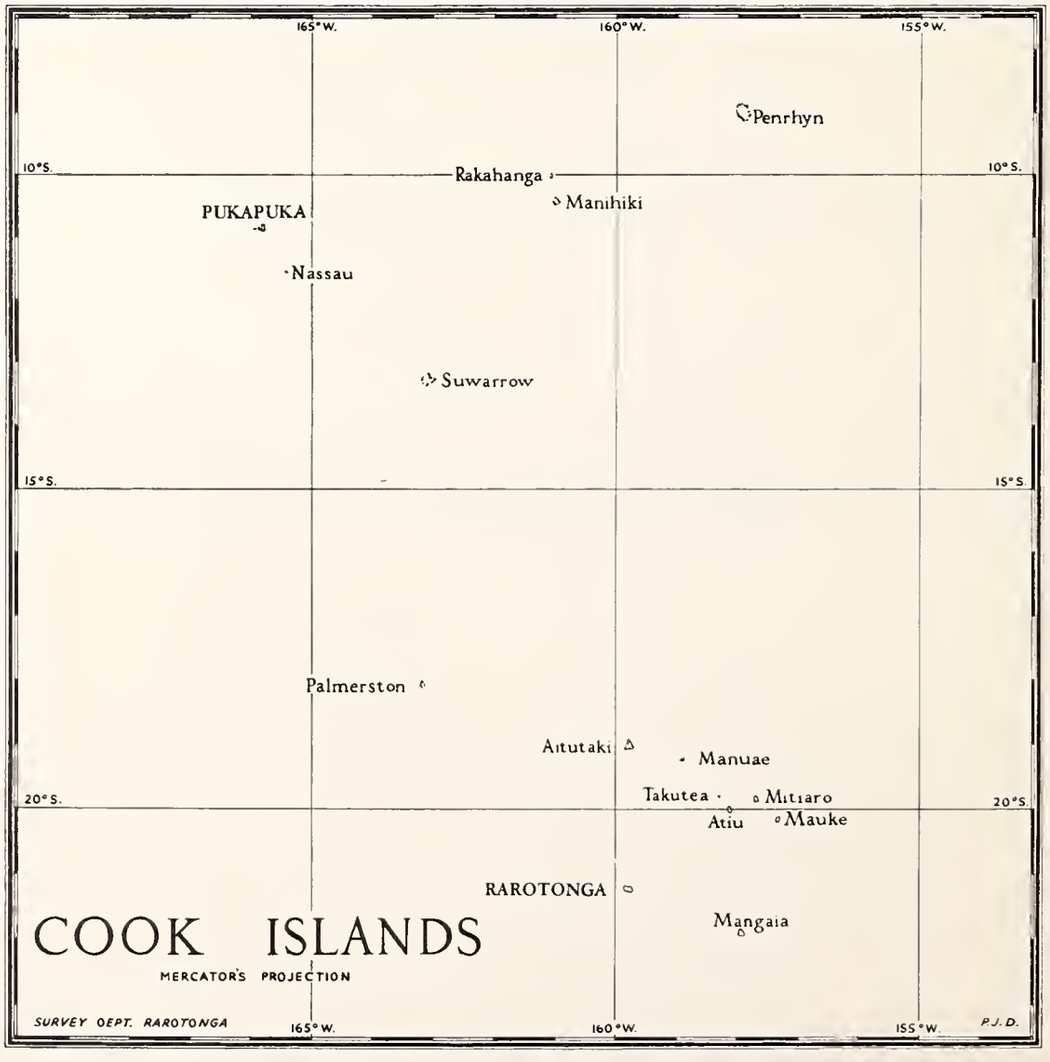




RAROTONGA ISLAND

SCALE

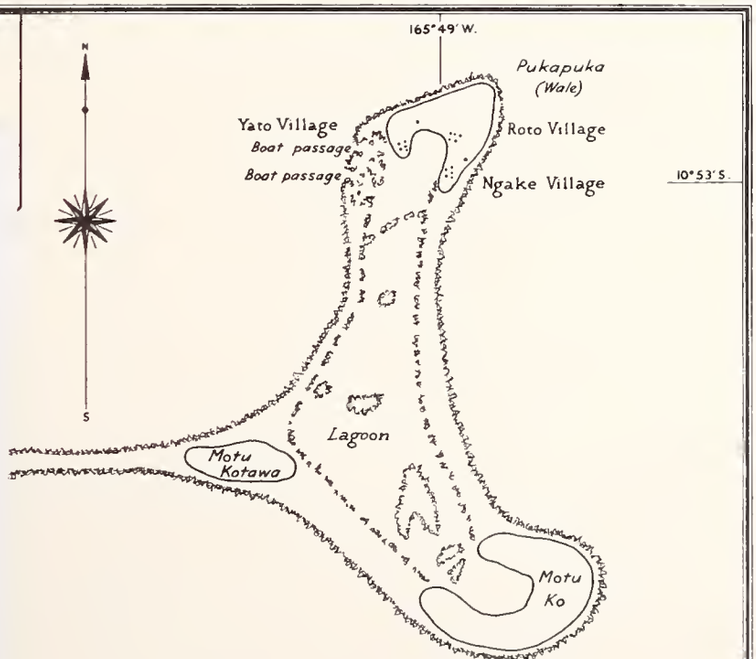
MILES 1 3/4 1/2 1/4 0 1 2 3 MILES

SURVEY DEPT RAROTONGA

Compiled from Survey Records

R.L.C.

Area : 300 Acres
Population : 109 (1961)
Miles from Pukapuka : 48



PUKAPUKA ISLAND

SCALE

Miles 1 3/4 1/2 1/4 0 1

Compiled from
by R.D Frist

SURVEY DEPT. RAROTONGA

R.L.C.


U.S.S.R.
ALEUTIAN Is
UNITED STATES
JAPAN
Tokyo
Yokohama
San Francisco
Los Angeles
MEXICO
MIDWAY Is
HAWAIIAN ISLANDS
OAHU
HAWAII
WAKE
JOHNSTON
MARIANAS
GUAM
MARSHALL Is
PONAPE
TRUK
CAROLINE Is
LINE ISLANDS
FANNING
CHRISTMAS
TARAWA
GILBERT Is
NAURU
OCEAN
CANTON
NEW IRELAND
ELLICE Is
PHOENIX Is
SOLOMON Is
TOKELAU Is
MARQUESAS Is
NEW BRITAIN
PENRHYN
NUKU HIVA
MANIHIKI
FATU-HIVA
PUKAPUKA
SAMOA
NEW GUINEA
SOCIETY Is
FIJI
COOK Is
TUAMOTU Is
NEW HEBRIDES
AITUTAKI
TAHITI
VAVA'U
NIUE
RAROTONGA
NEW CALEDONIA
TONGATABU
TONGA
MANGAIA
TUBUAI
TUBUAI Is
HENDERSON
PITCAIRN
RAPA
AUSTRALIA
Brisbane
NORFOLK
KERMADEC Is
RAOUL
LORD HOWE
Auckland
Sydney
Canberra
Adelaide
NEW ZEALAND
Wellington
CHATHAM
Christchurch
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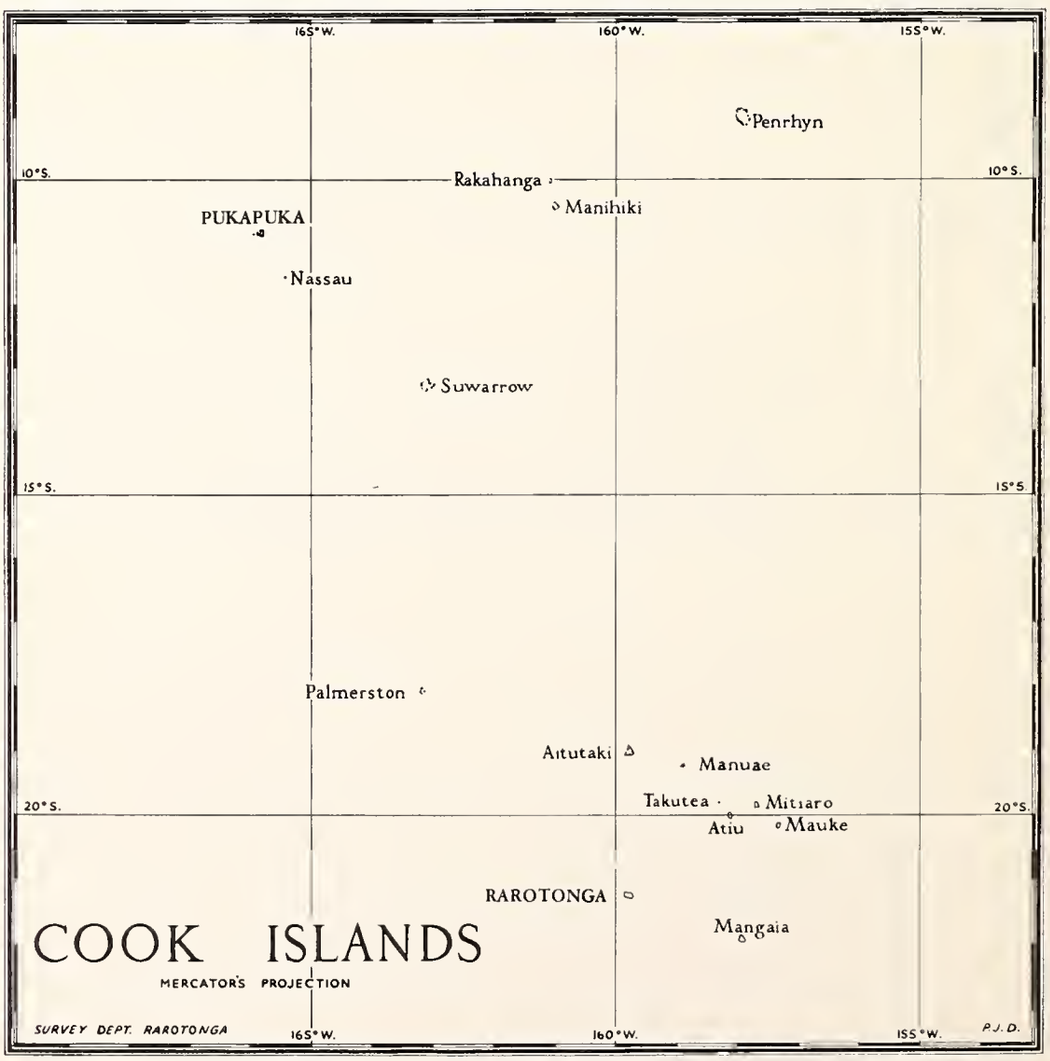
Dunedin
STEWART
PACIFIC OCEAN
Lambert's Azimuthal Equal Area Projection
SURVEY DEPT. RAROTONGA
N.M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Penrhyn
Rakahanga
Manihiki
PUKAPUKA
Nassau
Suwarrow
Palmerston
Aitutaki
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